



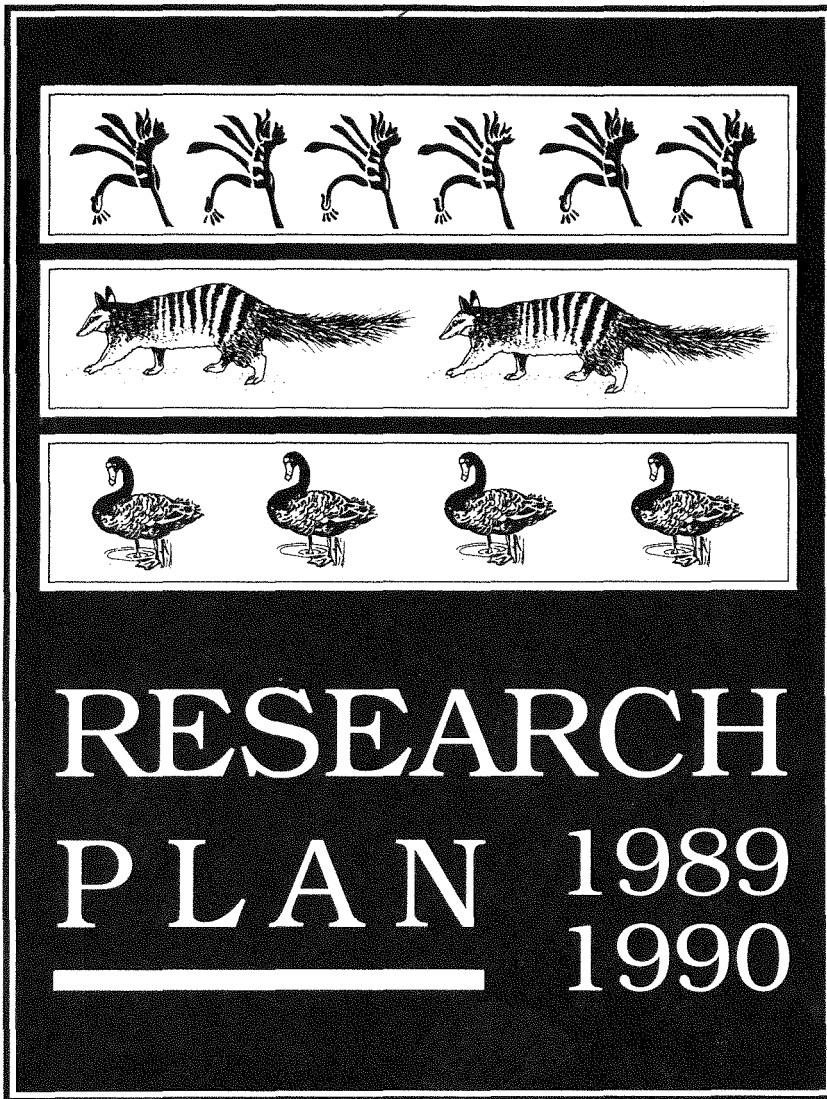
RESEARCH  
PLAN 1989  

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1990



DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT



DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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## PREFACE

This, the third Research Plan of the Department of Conservation and Land Management, consolidates the work carried out to produce the past two Plans and provides new information relevant to the output of Research Division.

As well as including updated sections on the overall mission, objectives, organization and research programs of the Division, the Plan has new sections giving details of scientific papers and reports approved for publication, seminars given by Divisional staff and new research projects approved during the past year. An important addition to this Plan is the Marine Conservation Research Program.

I would like to thank all those who have contributed to the preparation of the Research Plan, particularly the Program Leaders, who revised their sections, Ian Abbott, who had overall responsibility for its preparation, and Jeanette Gilmour, who co-ordinated its production.



Andrew A. Burbidge  
Director of Research

30 June 1989





# EXECUTIVE SUMMARY

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## ADMINISTRATIVE CHANGES

In 1988-9 the re-organization of Research Division begun in 1987-8 was completed. In particular, the Policy Group led by the Director of Research was restructured so as to better supervise the research programs, and a new Curator of the Herbarium was appointed. Mr Jim Armstrong holds the rank of Senior Principal Research Scientist.

The appointment of Dr James Stoddart has enabled a Marine Conservation Program to commence.

## MAJOR ACHIEVEMENTS

The overall aim of Research Division is to develop a scientific basis for conservation and land management in Western Australia by conducting research and providing expert advice.

Performance indicators for effectiveness have been developed. These are the extent to which:

- the management planning process is supported by sufficient and adequate scientific information;
- operational planning and techniques are supported by sufficient and adequate scientific knowledge;
- fundamental scientific knowledge of the State's plants and animals is increased and promulgated through publications;
- external sources of funds for research are maximized; and
- external research agencies concentrate on problems relevant to CALM

The significant accomplishments of each program are summarized below.

## EXECUTIVE AND ADMINISTRATIVE SUPPORT PROGRAM

During 1988/89 the Program concentrated on three main areas: bringing all staff into the same titles, awards and conditions; improving financial management and reporting; and reviewing the

efficiency and organization of Research Programs and the Research Division Policy Group (RDPG).

Considerable progress has now been made towards achieving a uniform system of titles, conditions and awards (See Part 7). Account numbers and expenditure reporting systems were revised so that Program Leaders and the RDPG are better able to control expenditure. The Executive and Administrative Support Program was reviewed by RDPG in March 1989, resulting in some changes in duties and responsibilities of senior staff.

## BIOGEOGRAPHY PROGRAM

Field work for the National Rainforest Conservation Program, and the Yanchep National Park and Cape Arid National Park surveys was completed. Reviews of the flora of the Warren District and Shark Bay area were prepared for publication. Surveys of the Dampier Archipelago and the Southern Beekeepers Reserve were published. Flora lists for North West Cape, Porongurup and Torndirrup National Parks were prepared for use by Operations staff. A review of pastoral land for conservation was undertaken, and the update of the CTCRC System 7 report was completed.

## ENTOMOLOGY PROGRAM

An operational-scale experiment examining if a single autumn fire can reduce Jarrah Leafminer infestation was set up in Collie District. This consisted of a 240 ha plot, half of which was burnt in Spring 1988 and the rest burnt in Autumn 1989. Leafminer abundance was sampled before burning, as was the condition of the crowns of 180 sample jarrah trees.

The hypothesis being tested is that, because Autumn fires scorch tree crowns, the flush of new, small leaves would be unsuitable oviposition sites. The jarrah in the stand should then have one full year in which to develop crowns and increase starch reserves. If successful, the research could lead to modification of current fire protection practices in Jarrah forest.

Three species of parasitoid of Gumleaf Skeletonizer have been collected. One of these was common in the southern jarrah forest. Another occurred

infrequently, although in South Australia it is common.

Two biological forms of Gumleaf Skeletonizer have now been found in Western Australia. One form, with one generation per year, occurs in jarrah forest whereas a form with two generations per year occurs in the lower southern Wheatbelt and south coast near Walpole.

Identification of the Lerp infesting Flat-topped Yate has been verified as *Cardiaspina brunnea*. Prior to 1982 this species was known only from New South Wales.

Construction of a modern, functional insectary complex at the Manjimup Research Centre has been commenced.

## FAUNA CONSERVATION PROGRAM

Co-operative research on captive breeding of the Western Swamp Tortoise in 1988/89 resulted in the production of 11 hatchlings. It is hoped that these hatchlings can be reared to maturity and thus add substantially to the known numbers of this critically endangered reptile.

Continuing studies of the marine turtles have now shown that adult female green turtles dispersing from west Kimberley rookeries can travel as far as Northern Territory and Queensland waters. An Exmouth Gulf nesting loggerhead (one of only 21 females tagged) was also reported from the Northern Territory. A loggerhead turtle nesting at Varanus Island in the Lowendal Islands Nature Reserve in the 1988/89 season was the fourth nesting species to be recorded from this site. Continued involvement of West Kimberley Aboriginal people in the project work was sustained and at North West Cape - Ningaloo and in the Pilbara, other members of the public were successfully involved.

Better reporting of the occurrence of leatherback turtles in Western Australian west coastal areas has pointed to a possible problem of significance to conservation of this most endangered marine turtle. The majority of reports have resulted from fatal but accidental entrapment in commercial fishing gear.

Some important flatback turtle rookery sites have been identified off the Kimberley coast.

Funding from World Wildlife Fund Australia permitted expansion of research on the Ground

Parrot. It was discovered that breeding commenced at least two months earlier than previously believed, and that these birds were inhabiting long unburnt plant species-rich heaths, and were also at much lower densities than in eastern Australia.

Surveys in February 1989 at Boyagin Nature Reserve showed that the Numbat re-introduction project conducted through 1985-87 was having continued success. Numbats were found through most of the eastern half of the reserve.

Numbats were also bred in captivity again, the only success since 1985, when it was first achieved. Provision of improved diet and quiet surroundings apparently contributed to this favourable result.

Wheatbelt rock-wallaby populations remained high, continuing to demonstrate the value of fox control in protecting remnant mammal populations.

Further information on distribution of the Chuditch was obtained and a reporting network at Operations level initiated.

## FIRE PROGRAM

In the arid zone, a study of early black and white aerial photography was initiated to gather information on Aboriginal burning practices in desert areas. In association with this work, patch burning, using incendiaries dropped from aircraft, was implemented successfully in the Gibson Desert Nature Reserve. Data on fire behaviour, and the response of mammal, bird and reptile populations to these burning patterns are also being gathered in this Reserve. Similar work on the effect of fire on small desert vertebrates is also being undertaken at Queen Victoria Spring Nature Reserve. In the Goldfields a plan for fire research and management of desert reserves was prepared in conjunction with Regional staff.

In the south-west of the State a successful experimental burn was carried out in Durokoppin Nature Reserve (near Kellerberrin) in mid March 1989; work on invertebrates in the burnt area and on adjacent unburnt plots is continuing. Near the south coast, integrated studies on fire behaviour and the effects of fire on vegetation and small vertebrates have commenced in mallee-heath shrublands in the Stirling Range National Park. Work on invertebrates (particularly spiders, beetles and termites) in relation to fire is also underway in the Park, through a consultancy using funds provided by the World Wildlife Fund. Guidelines for eradicating wildings

from *Pinus radiata* plantations were provided for use by Operations staff; and a summary of information concerning the fire ecology of rare plants occurring in south-west forests also was prepared.

The proceedings of the National Workshop on Fire Management on Nature Conservation Lands, hosted by CALM in October 1987, was published as a Departmental Occasional Paper 1/89 in May 1989. Copies have been distributed to all Workshop delegates, and to many individuals and organizations concerned with fire management and conservation in Australia. The document makes a valuable contribution to knowledge of this subject.

### FLORA CONSERVATION PROGRAM

Two Rare Flora Wildlife Management Programs - one for all rare flora in the Northern Forest Region and the other for the Rose Mallee (*Eucalyptus rhodantha*) - have been completed and will be published in mid 1989. These are the first Wildlife Management Programs to deal with rare flora and the program for the Northern Forest Region is the first in a series which will eventually cover all CALM regions.

The rare flora data base has been expanded and now consists of five categories of priority species in addition to the Declared Rare Flora. Updating the schedule of Declared Rare Flora has continued with the new list to be released in mid 1989.

### HERBARIUM PROGRAM

The Herbarium was formally amalgamated into CALM and the process of integrating its functions with those of the Research Division commenced. A new interim Herbarium structure has been established to facilitate the integration process and to optimise productivity.

Regional Herbaria at Albany and Manjimup were acquired by CALM; these, together with the Karratha Regional Herbarium, now form the nucleus of CALM's Regional Herbarium Network.

Herbarium staff made significant contributions to the Kimberley Regional Flora Project as well as to two external projects: the Flora of Australia and the Flora of New South Wales.

Two significant collections were processed and incorporated into the Herbarium during the year. These were the Ken Newbey collection

(5 000 specimens) and The University of Western Australia collection (15 000 specimens). The *Verticordia* Reference Collection, prepared by the *Verticordia* Study Group, was incorporated into the Herbarium's Community Reference Herbarium.

A number of important research papers were published during the year, including one interpreting biogeographic patterns in *Acacia*.

### MARINE CONSERVATION PROGRAM

A major research and monitoring program has been established at Ningaloo Marine Park, including a survey of the entire Ningaloo Reef to examine the predator-prey relationship of *Drupella* and corals.

### PLANT DISEASES PROGRAM

Highlights of plant disease research extension has been the production of a major review of *Phytophthora cinnamomi* in the jarrah forest and a nine minute video on south coast dieback.

Systems using presence of indicator plant species have been developed to rate *P. cinnamomi* hazard in the high and the intermediate-low rainfall zones of the northern jarrah forest. The high rainfall zone system has been validated and accurately predicted 80% of the high impact (many jarrah dying or dead) types. The system for the intermediate-low rainfall zone is presently being validated. Under evaluation are potential improvements to the systems by the incorporation of position in the landscape and aspect.

Stress and growth of jarrah on *P. cinnamomi* infected high impact sites and on intermediate/low impact (few if any dead jarrah, few to many dead *Banksia grandis*) sites have been compared during summer droughts. Water stress was greatest in jarrah trees on infected sites than those on uninfected sites. The level of stress was greater on high than on intermediate/low sites. Overall effects of *P. cinnamomi* on tree growth are complex, being determined by the level of infection of individual trees and the "thinning effect" caused by the fungus killing competing trees on site.

Jarrah resistant to *P. cinnamomi* have been identified. The heritability of the resistant character in the field trial was found to be 0.86. A broader screening program has now commenced to select resistant lines for use in a *P. cinnamomi*-resistant jarrah seed orchard.

Research over the last two years has significantly advanced knowledge of the impact, development and spread of *Phytophthora* species in non-forested areas. The rate of expansion of disease in banksia woodland infected with *P. cinnamomi* has been determined from aerial photographs over a period of 35 years. When not assisted by movement of soil or free water the diseased areas increased by  $1.0 \text{ m yr}^{-1}$ . In two banksia woodland communities the fungus was recovered from groundwater 3 m and 5 m below the soil surface.

A major investigation of the impact of *P. cinnamomi* on the vegetation of the Stirling Range National Park commenced in December. Collections have accumulated in excess of 523 plant species representing 432 herbarium vouchers and 466 field vouchers. Of the 281 plant species rated for susceptibility to the fungus, one third were affected by disease and 30% of these were very susceptible. Relationships between community structure and impact of the disease have been determined.

Assessment of chemicals to control *Phytophthora* species is a continuing high priority. One application of metalaxyl significantly reduced recovery of *P. cinnamomi* from colonized pine plugs buried up to 1.3 m in Bassendean Dune sand. Ten per cent phosphorous acid has arrested lesion extension in *B. grandis*.

Isozyme analysis has been used to determine the identity of *Endothia* and *Cryphonectria* species isolated from cankers of jarrah.

Of the 318 cultures that were forwarded by the detection service for the identification of *Phytophthora* species, 59 were identified to species level. A database of distribution and hosts of *Phytophthora* species is being compiled from the sampling data.

### REHABILITATION PROGRAM

The long involvement in rehabilitation after bauxite mining in the jarrah forest has been substantially concluded with the publication of a major review and with the introduction of comprehensive dieback control procedures into the mining operation.

The Rehabilitation program has made a large contribution to the emergence of short-rotation eucalypts as a potential farm crop. Such a crop is of great importance to agriculture, water resources and riverine and wetland conservation throughout the lower south west. To further enhance the

development of the crop a large three year Federal Government grant under the National Afforestation Program has been obtained. This will be a major part of the program's activity for this period. It is clear that farm tree planting will need to integrate with other farming practices and the long period of research into agro-forestry undertaken within the Rehabilitation and Silviculture programs will prove especially valuable in helping to achieve this.

Farm tree planting research in drier areas (less than 600 mm rainfall per year) has been concluded and will be replaced with a project to identify and develop management practices for remnants of native vegetation on farms.

### RESEARCH COMPUTING SUPPORT PROGRAM

The goal of providing at least one personal computer terminal per research scientist was accomplished. Training courses were conducted regularly at Woodvale, Herbarium, Manjimup and Busselton. There has been a considerable increase in the level of computer literacy, expertise and useage among Research Division staff.

Within the Division the computing approach and equipment in use have been standardized. Hardware and software have been integrated.

The NUMTRACK system was transferred from the Tektronix to the VAX.

A Video digitizer has been acquired.

### RESEARCH METHODS SUPPORT PROGRAM

In the past year 40 Research Project Plans have been vetted. Some of these plans extend into the next century. Data sets drawn from fauna conservation, silviculture, hydrology, timber technology, human recreation, biogeography, wetlands, entomology and plant disease have been analysed. New methods such as a Community Attrition Index and a novel approach to measuring the pattern and density of natural entities have been developed.

### SILVICULTURE PROGRAM

In the past year a range of major long term silviculture experiments commenced. In the jarrah forest a family/provenance trial comprising 250 families from 25 populations from the main range of

jarrah forest was established in regenerated forest on minesites at Huntly and Jarrahdale. Large scale experiments examining the interaction between thinning and fertilizer were established in both karri forest and radiata pine plantations. These experiments will yield data on the effects of intensive management on the productivity of these systems. It is intended to replicate these experiments on a range of sites.

Experiments on the chemical emasculation of *Pinus radiata* have demonstrated that pollen production can be inhibited. This major advance will allow much greater control of pollination within the new hedged artificially pollinated seed orchard (HAPSO) at Manjimup and thus increase the gains possible from pine breeding. A second generation *P. pinaster* seed orchard was also established at Manjimup during 1988. This will allow the consolidation of gains made by *P. pinaster* breeding research.

A survey of factors affecting the occurrence of drought death in *P. radiata* plantations in the Blackwood Valley was conducted in 1988. The major factors found to influence the occurrence of drought death are tree stocking, soil depth, landscape position, and aspect. The understanding of the interaction between these factors will allow better prediction of the stocking that different sites can carry. A survey of the factors that contributed to the severe windthrow in the sunkland pine plantations was also carried out.

A major review of research on the interaction between *Phytophthora cinnamomi* and *Pinus radiata* was completed. Resistance to the infection of *P. radiata* by *P. cinnamomi* is under strong genetic control. It appears that the resistance of *P. radiata* to *P. cinnamomi* is controlled by a large number of genes each having a small but additive effect. To minimize productivity losses in plantations it is essential that resistance to *P. cinnamomi* be included as a major character in the genotype of seedlings and cuttings used in afforestation.

A study of the economics of pine agroforestry in the 500-700 mm rainfall zone was carried out in conjunction with Economics Branch using data from long term experiments near Mundaring.

## WETLANDS AND WATERBIRDS PROGRAM

Significant accomplishments were:

Publication of "Wetlands in Nature Reserves of South-Western Australia, 1981-1985" RAOU Report No. 30.

State Government commitment to funding a major new project on waterbird usage of wetlands of the Swan Coastal Plain.

Publication of a major review paper - "Western Australian Wetlands" - concerning the characteristics, conservation and management of the State's wetlands.

Department commitment to funding a three year continuation and expansion of annual waterfowl abundance monitoring in South-Western Australia.

Significant advances in methodology of monitoring and controlling populations of nuisance midges (chironomids) on Perth's wetlands.

Assessment of potential for harvesting of saltwater and freshwater crocodiles (*Crocodylus porosus* and *C. johnstoni*) in Western Australia.

## WOOD UTILIZATION PROGRAM

Continuing trials of stockpiling jarrah logs under watersprays showed that a regime of 15 minutes on and 165 minutes off did not adversely affect log quality. This is a 92 per cent saving in water and energy required to operate pumps. A trial using low pressure watering systems to stockpile logs was commenced.

Sawmilling trials of regrowth jarrah, karri, marri and Tasmanian blue gum were carried out. All species produced satisfactory sawn recoveries.

Timber drying studies continued, using a research batch kiln and an experimental high temperature kiln.

The major advance was the development of a system to edge-joint and face-joint thin sections of regrowth eucalypts to produce either furniture quality panels or structural material. This has great advantages for the forest products industry and furniture manufacturers.

A study of radiata pine assessed the sawn graded recoveries from logs taken from the green crown of the trees.

Several successful field days at the Wood Utilization Research Centre, Harvey, resulted in research findings being taken up by industry and put into commercial practice. Wood Utilization staff delivered lectures on wood properties to students in the TAFE Certificate in Timber Technology. Seven WURC Reports were published during the year, and six Technical Reports for limited distribution prepared.

### Accommodation

Shortage of laboratory and office space was overcome at the Como Research Centre. However, major problems remain at the Dwellingup, Herbarium and Woodvale centres and the Herbarium has run out of space for housing new plant collections.

### External liaison

Co-operation among Government departments and between Government departments and private organizations continue to be of an excellent standard. Research staff have often been called upon in a consultative capacity over the year. Collaborative studies have been conducted with a number of Government departments and organizations.

External funds were received to carry out and continue with a number of research projects throughout the year. Major funding bodies during 1988/89 were Australian National Parks and

Wildlife Service (\$93,000), World Wildlife Fund of Australia (\$60,000), Australian Biological Resources Study (\$79,000), Western Australian Heritage Committee (\$10,000), ALCOA (\$90,000), Department of Industry, Technology and Commerce (\$386,000), Department of Arts, Sport, the Environment, Tourism and Territories - National Rainforest Conservation Program (\$110,000), Department of Primary Industries and Energy - National Afforestation Program (\$500,000). In addition \$20,000 was again received from the Western Australian Department of Agriculture as part of the National Soil Conservation Program for a three-year research project at Esperance.

### Research project plans

All proposed research is vetted for relevance, cost effectiveness and scientific excellence. During 1988/89 40 of these plans were approved (see Part 10).

### Publications

All manuscripts are reviewed by appropriate senior staff for scientific merit and policy implications before papers are submitted to scientific journals for publication. During 1988/89, 50 papers were approved. In addition, over 80 papers and reports were published by Research Division staff during the year. Most of these appeared in journals published by organizations independent of CALM; this helps ensure that the research done receives external refereeing and achieves national and international exposure, thereby maintaining the high scientific profile enjoyed by CALM.

### Seminars

Seventeen formal seminars (see Part 9) were presented by Research Division staff during the year, with CALM staff outside Research Division and scientists from Tertiary institutions and other Government agencies in attendance, as well as members of the public.

## SCOPE

This research plan relates to the work carried out by the Department's Division of Research and does not include research conducted in other Divisions. It is a rolling plan and will be revised each year in July.

Production of a rolling five-year plan is considered the best way of clearly describing the what, why, where, who, when and how of research.

CALM's Corporate Plan requires that each functional group within the Department prepare its own Strategic Plan. This Plan fulfils this requirement for the Division of Research. The information in this plan is correct to 30 June 1989.

## HISTORICAL OVERVIEW - A Brief Synopsis

The Department of Conservation and Land Management was officially created on 22 March 1985 through the amalgamation of the Forests Department, National Parks Authority and the wildlife component of the Department of Fisheries and Wildlife. The amalgamation saw the creation of the Research and Planning Division as part of the Policy Directorate of CALM. An internal reorganization in 1986 led to the formation of a new

Division placed within the Operations part of the Department. Research was at this stage divided into two branches - Production and Protection Research, and Wildlife Research. Mr Joe Havel was the first Director of Research and Planning.

The Division was further reorganized in 1987 with the appointment of Dr Andrew Burbidge as Director of Research. A program structure was adopted at this time with modifications being made in July 1988. The final structure of research programs adopted was: Executive and Administrative Support, Biogeography, Entomology, Fauna Conservation, Fire, Flora Conservation, Plant Diseases, Rehabilitation, Research Computing, Research Methods, Silviculture, Wetlands and Waterbirds and Wood Utilization. In July 1988 the West Australian Herbarium was incorporated into the Research Division of CALM. Before this the Herbarium came under the administration of the Department of Agriculture. The Herbarium was incorporated as a program. December 1988 saw the appointment of the Department's first Marine Research Scientist. A Marine Conservation Program is currently being developed.

A more detailed historical overview of the Division is contained in the 2nd edition of this Plan.

## PART 2

## ORGANIZATION

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The Division of Research is one of seven Divisions of CALM under the overall control of the General Manager and Executive Director. The Division is led by the Director of Research, and a corporate team consisting of three Senior Principal Research Scientists (including the Curator of the WA Herbarium) and two Principal Research Scientists (Figure 1). Internal organization is on the basis of Research Programs, each led by a Program Leader. Staff are located at five Research Centres, each under the administrative control of a Research Centre Manager. Some Como Research Centre staff are located at Albany, Bunbury, Narrogin and Wanneroo District Offices. Research Scientists located at Kalgoorlie and Karratha Regional Headquarters were transferred to Woodvale during 1988/89.

### RESEARCH DIVISION POLICY GROUP

The Research Division Policy Group was set up for several reasons:

To spread the workload, increase efficiency and alleviate stress in the senior staff of a large, complex organization.

To allow scientists with different backgrounds and expertise to apply their skills to the benefit of the Division. The Division embraces a very broad range of research projects and areas, too many for any one person to be proficient in.

To allow senior staff to spend some of their time carrying out and applying research.

To be in line with the trend in modern management of corporate decision making.

A review of the Executive and Administrative Support Program in March 1989 resulted in modifications to the roles of RDPG members.

In broad terms, duties of the members of RDPG are as follows (for greater detail, see the Executive and Administrative Support Program, Part 11):

#### **Director of Research - Andrew Burbidge**

Responsible for overall final decision-making and leadership of Research Division, chairing of RDPG

meetings, and attending and contributing to Departmental Policy Directorate meetings. Concentrates on the external environment, both regarding the Department and the public.

#### **Senior Principal Research Scientist - Per Christensen**

Responsible for Research Centre Managers at Como (and its outstations), Manjimup and Busselton. Responsible for the Silviculture, Wood Utilization, Rehabilitation and Entomology Programs and for the administrative areas of Wood Utilization Research Centre, Directors of Research Committee (Forestry Council), Research Steering Committee, interaction with Forest Resources Division.

#### **Senior Principal Research Scientist - Steve Hopper**

Responsible for the Woodvale (and its outstations) Research Centre Manager. Responsible for the Biogeography, Fauna Conservation, Fire, Wetlands and Waterbirds and Marine Conservation Programs. Responsible for the administrative areas of Working Group on Land Releases, interaction with Nature Conservation Division with respect to fauna, endangered fauna and land reservation, mining (Bailey Committee procedures).

#### **Senior Principal Research Scientist (Curator, Herbarium) - Jim Armstrong**

Responsible for the staff at the Herbarium and the Research Centre Manager at Dwellingup. Responsible for the Herbarium, Flora Conservation and Plant Diseases Programs, and for the administrative areas of the Herbarium collection, interaction with Nature Conservation Division on matters relating to flora and endangered flora and with all Divisions on plant diseases. Represents Western Australia on the Council of Heads of Australian Herbaria.

#### **Principal Research Scientist - Tony Start**

Assists SPRS Steve Hopper. Responsible for the Research Computing Program. Responsible to the Director of Research, through RDPG, for the following administrative areas: staff administration, co-ordination of budget preparation and administration, co-ordination of the review of



ERMPs, draft Management Plans and Guidelines for Necessary Operations.

#### **Principal Research Scientist - Ian Abbott**

Assists SPRS Per Christensen. Responsible for the Research Methods Program. Responsible for the following administrative areas: scientific publishing and SPEC (Scientific Publishing and Editorial Committee), Library Committee, organization of seminars, annual revision of this Research Plan, co-ordination of Research Division contribution to the Annual Report.

In addition to the above duties, SPRSs and PRSs attend all meetings of Programs under their control and meet with Research Scientists in Programs under their control at least twice per year.

#### **Principal Research Scientist (Special Projects) - John Bartle**

Not a permanent member of RDPG, but called upon as required to work on allocated special projects and integrated land use management.

#### **PROGRAM LEADERS**

Program Leaders were initially elected by members of the Program for a 3 year term but are now appointed by RDPG. Their duties in priority order are as follows:

Coordinate research in the program and in conjunction with responsible SPRS/PRS maintain scientific standards.

Review proposed Research Project Plans, manuscripts and publications from program members.

Generate momentum and *esprit de corps* in the Program.

Financial control - prepare budgets and distribute allocated finance within the program.

Provide information to the Department on costs and benefits of research carried out within the program and other matters as required.

Be the first point of contact for managers and other staff with technical questions regarding the program.

Seek opportunities for positive interaction with Managers in other Divisions.

Contribute to and revise the relevant program section of the Research Plan.

Co-ordinate program responses to technical reviews of referred documents, e.g. Draft Management Plans, Environmental Review and Management Programs, Guidelines for Necessary Operations.

Foster links between programs where appropriate.

Maintain external liaison with other research institutions, tertiary institutions and promote joint research.

Co-ordinate research grant applications for work in the program.

Participate in Program Leader meetings.

#### **RESEARCH CENTRE MANAGERS**

Research Centre Managers are appointed by RDPG. Their duties are as follows:

Promote a safe, productive and friendly work environment at the Centre;

Co-ordinate the use of facilities and equipment at the Centre and the provision of new facilities;

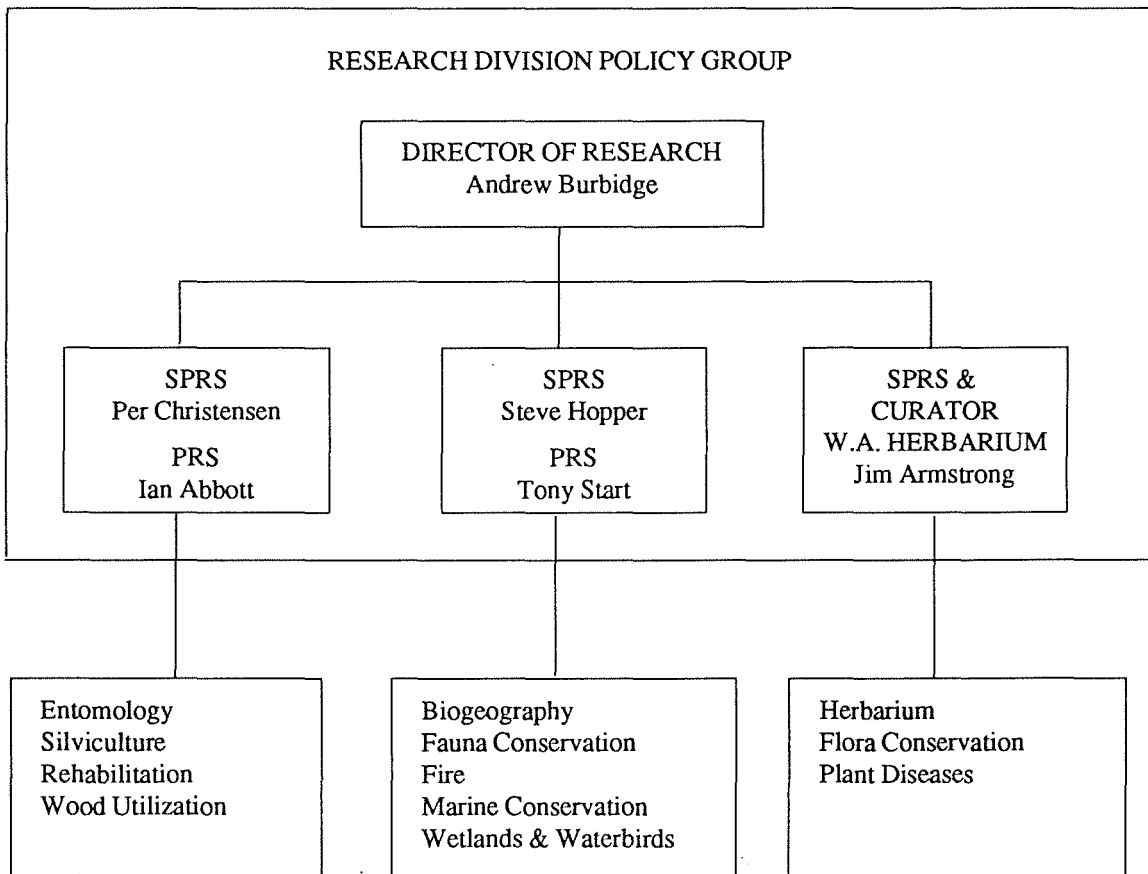
Prepare budgets for and control expenditure of Research Centre cost items;

Be responsible for general management of staff based at the Centre;

Seek opportunities for positive interaction with managers of other parts of the Department, particularly within the District and Region in which the Research Centre is located.

**Figure 1**  
**Line Responsibility in RDPG**

The Programs Executive and Administrative Support, Research Computing and Research Methods are responsible to the Director of Research, PRS T. Start and PRS I. Abbott respectively.



**Table 1**  
**Principal Officers of the Research Division**

*\*Co-opted as required*

**Research Division Policy Group**

Director of Research	A.A. Burbidge, <i>BSc(Hons)PhD(W.Aust)</i>
Senior Principal Research Scientist & Curator, Western Australian Herbarium	J.A. Armstrong, <i>BScAgr(Hons)(Sydney)</i>
Senior Principal Research Scientist	P. Christensen, <i>BSc(Hons)(Rhodes)PhD(W.Aust)</i>
Senior Principal Research Scientist	S.D. Hopper, <i>BSc(Hons)PhD(W.Aust)</i>
Principal Research Scientist	A.N. Start, <i>BSc(Hons)PhD(Aberdeen)</i>
Principal Research Scientist	I. Abbott, <i>BSc(Hons)(Sydney)PhD(Monash)</i>
Principal Research Scientist (Special Projects)	J.R. Bartle, <i>BSc Agr(W.Aust)*</i>

**Program Leaders**

Executive and Administrative Support	A.A. Burbidge, <i>BSc(Hons)PhD(W.Aust)</i>
Biogeography	G. J. Keighery, <i>BSc(Hons)(W.Aust.)</i>
Entomology	I. Abbott, <i>BSc(Hons)(Sydney)PhD(Monash)</i>
Fauna Conservation	J.A. Friend, <i>BSc(Hons)PhD(Tasmania)</i>
Fire	N.D. Burrows, <i>BScFor(Aust.Nat.Univ)</i>
Flora Conservation	D.J. Coates <i>BSc(Hons)PhD(W.Aust)</i>
Herbarium	J.A. Armstrong, <i>BScAgr(Hons)(Sydney)</i>
Marine Conservation	J.A. Stoddart, <i>BSc(Hons)MSc,PhD(W.Aust.)</i>
Plant Diseases	B.L. Shearer, <i>BScAgr(Hons)(W.Aust)PhD(Minnesota)</i>
Rehabilitation	J.R. Bartle, <i>BScAgr(W.Aust)</i>
Research Computing	M.H.C. Choo, <i>BSc(Hons)MSc(Loughborough)</i>
Research Methods	D.J. Ward, <i>B.Appl.Sci(WAIT)</i>
Silviculture	J.F. McGrath, <i>BScAgr(Hons)PhD(W.Aust)</i>
Wetlands & Waterbirds	J.A.K. Lane, <i>BSc(W.Aust)</i>
Wood Utilization	G.R. Siemon, <i>BScFor(Hons)PhD(Aust.Nat.Univ)</i>

**Research Centre Managers**

Como	G.R. Siemon, <i>BScFor(Hons)PhD(Aust.Nat.Univ)</i>
Dwellingup	B.L. Shearer, <i>BScAgr(Hons)(W.Aust)PhD(Minnesota)</i>
Herbarium	J.A. Armstrong, <i>BScAgr(Hons)(Sydney)</i>
Manjimup	W.L. McCaw, <i>BForSc(Hons)(Melbourne)</i>
Woodvale	J.A.K. Lane, <i>BSc(W.Aust)</i>

## PART 3

## RESOURCES

In 1988/89 the Division comprised 48.3 Professional and 81.9 Technical and Clerical staff, totalling 130.2 persons (full time equivalent). Some of these persons were casual or part-time.

The total CRF budget in 1988/89 was \$5 984 352 consisting of \$3 969 702 for salaries and \$2 014 650 for operating costs (research, wages, travel and plant).

In 1988/89 Research Division accounted for 8.57% of staff positions and 7.34% of the Department's

total budget. The corresponding figures for 1987/88 were 9.07% and 6.66%

Resources in 1988/89 are summarized for each Program in Tables 2 and 3.

Estimated resources for 1989/90 for each program are summarized in Tables 4 and 5. Wood Utilization is omitted from all tables as its budget is managed by the Division of Forest Resources through the Public Interest Project.

**Table 2**  
**Summary of Resources 1988/89 in Research Division (CRF)**

Program	Prof Staff	Tech Cler Staff	No. People	% Staff	Salaries \$	Operating Budget \$	Total \$	Finance %
Executive & Administrative Support (including Publications)	5.15	16.5	21.65	16.70	614 945	376 207	991 152	16.56
Biogeography	3.65	3.6	7.25	5.57	248 612	129 560	378 172	6.32
Entomology	1.6	4.3	5.9	4.53	137 058	32 270	169 328	2.83
Fauna Conservation	4.4	4.7	9.1	7.0	321 211	149 015	470 226	7.85
Fire	5.35	10.45	15.8	12.20	491 429	197 560	688 989	11.51
Flora Conservation	1.55	2.15	3.7	2.84	130 751	63 710	194 461	3.40
Herbarium	10.7	5.0	15.7	12.11	606 547	327 000*	933 547	15.60
Marine Conservation	0.5	0	0.5	0.50	22 219	9 000	31 219	0.52
Plant Diseases	2.3	8.9	11.2	8.60	321 009	160 238	481 247	8.00
Rehabilitation	2.95	3	5.95	4.57	191 101	51 965	243 066	4.00
Research Computing	2	1.6	3.6	2.75	111 769	148 310	260 079	4.35
Research Methods	2	0.5	2.5	1.92	59 459	19 150	78 609	1.31
Silviculture	4.45	19	23.45	18.10	583 158	287 255	870 413	14.55
Wetlands & Waterbirds	1.7	1.7	3.4	2.61	130 434	63 410	193 844	3.20
<b>Research Division Total</b>	<b>48.3</b>	<b>81.9</b>	<b>130.2</b>	<b>100</b>	<b>3 969 702</b>	<b>2 014 650</b>	<b>5 984 352</b>	<b>100</b>

**Table 3**  
**Summary of External Resources 1988/89 in Research Division**

<b>Program</b>	<b>Prof Staff</b>	<b>Tech Cler Staff</b>	<b>No. People</b>	<b>% Staff</b>	<b>Salaries \$</b>	<b>Operating Budget \$</b>	<b>Total \$</b>	<b>Finance %</b>
Executive & Administrative Support	0	1	1	5.20	17 700	0	17 700	1.61
Biogeography	0	1.4	1.4	7.30	35 000	74 850	109 850	10.00
Fauna Conservation	0.5	0	0.5	2.60	15 000	119 680	134 680	12.26
Flora Conservation	1	0	1	5.20	27 000	3 000	30 000	2.73
Herbarium	1	1.5	2.5	13.02	69 000	11 020	80 020	7.28
Plant Diseases	1	2	3	15.63	87 000	3 400	90 400	8.23
Rehabilitation	5	4.8	9.8	51.05	251 600	384 500	636 100	57.89
<b>External Total</b>	<b>8.5</b>	<b>10.7</b>	<b>19.2</b>	<b>100</b>	<b>502 300</b>	<b>596 450</b>	<b>1 098 750</b>	<b>100</b>

**Table 4**  
**Estimate of Resources 1989/90 in Research Division (CRF)**

\* Unfunded positions in the Biogeography, Fauna Conservation, Fire and Marine Conservation Programs will be allocated an operating budget from the Executive and Administrative Support Program's Contingency Fund. Finance % column figures will be altered accordingly in next years Plan.

<b>Program</b>	<b>Prof Staff</b>	<b>Tech Cler Staff</b>	<b>No. People</b>	<b>% Staff</b>	<b>Salaries \$</b>	<b>Operating Budget \$</b>	<b>Total \$</b>	<b>Finance %</b>
Executive & Administrative Support (includes Publications)	6.55	17.45	24.00	17.60	874 563	511 405	1 385 968	21.44
Biogeography	5.80	5.35	11.15	8.18	383 311	107 410	490 721	7.60*
Entomology	1.6	4.3	5.9	4.32	184 258	34 270	218 528	3.38
Fauna Conservation	3.95	4.85	8.8	6.45	282 977	149 450	432 427	6.70*
Fire	5.95	10.25	16.2	11.88	551 807	198 055	749 862	11.60*
Flora Conservation	1.30	1.75	3.05	2.23	113 005	63 710	176 715	2.73
Herbarium	10.25	5.10	15.35	11.25	602 114	67 350	669 464	10.36
Marine Conservation	1.40	0.50	1.90	1.40	78 368	to be allocated	78 368 + op. budget	1.21*
Plant Diseases	3.30	8.80	12.10	8.88	379 509	159 240	538 749	8.33
Rehabilitation	3.35	3.75	7.10	5.20	236 851	51 965	288 816	4.47
Research Computing	3.10	0.10	3.20	2.34	108 064	147 200	255 264	3.94
Research Methods	1.90	0	1.90	1.39	73 380	19 150	92 530	1.44
Silviculture	4.25	18.30	22.55	16.53	605 809	296 255	902 064	13.95
Wetlands & Waterbirds	1.50	1.70	3.20	2.35	126 307	58 940	185 247	2.86
<b>Research Division Total</b>	<b>54.20</b>	<b>82.20</b>	<b>136.40</b>	<b>100</b>	<b>4 600 323</b>	<b>1 864 400</b>	<b>6 464 723</b>	<b>100</b>

**Table 5**  
**Estimate of External Resources 1989/90 in Research Division**

Note: The outcome of applications for external funds during 1989/90 cannot be accurately forecast, therefore this table is incomplete. A complete and accurate table will be published in the next edition of this Plan.

Program	Prof Staff	Tech Cler Staff	No. People	% Staff	Salaries \$	Operating Budget \$	Total \$	Finance %
Executive & Administrative Support	0	1	1	5.46	18 300	-	18 300	1.75
Fauna Conservation	0.5	0	0.5	2.73	16 000	120 000	136 000	13.00
Flora Conservation	2.5	0	2.5	13.66	69 000	10 000	79 000	7.55
Herbarium	1	1.5	2.5	13.66	63 350	7 777	71 127	6.80
Marine Conservation	0	0	0	0	0	57 000	57 000	5.45
Plant Diseases	1	2	3	16.39	89 200	-	89 200	8.52
Rehabilitation	4	4.8	8.8	48.10	311 100	285 000	596 100	56.93
External Total	9	9.3	18.3	100	566 950	479 777	1 046 727	100

## **PART 4 ALLOCATION OF PRIORITIES FOR RESEARCH**

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Ideally research priorities should be allocated according to explicit criteria. These criteria should be able to deliver an objective and decisive priority allocation at any level of research (i.e. program, goal, project). They should be used to guide the smooth transfer of resources from terminating and low priority areas into high priority areas.

Considerable effort was put into debate and development of this ideal in preparation for this revision of the 5 year plan. It was concluded that a purely objective and explicit system was probably unattainable. Too many social and political factors which cannot be resolved into simple criteria impose a framework that constrains priority allocation and transfer of resources.

It was therefore decided to provide a general overview of major social and political factors which impinge on priority setting as well as a listing of definable criteria by which a finer tuning of priorities can be achieved.

### **SOCIOPOLITICAL FACTORS IN PRIORITY ALLOCATION**

#### **Relative priority of conservation versus production related research**

CALM has responsibilities for both production and conservation research. Conservation activity is not directly revenue generating. On the other hand, production activity does generate revenue and, if well supported by research, its revenues will grow. Within CALM, or ultimately within society at large, it is revenue from production activity which funds conservation. Also the greater the level of production activity, the greater the need for conservation effort. Conceptually, therefore, there must be a balance between expenditure on research for production and conservation.

#### **Relative priority of research in different geographic areas**

The CALM estate includes lands in the intensively used south-west, the largely unoccupied arid lands, the less developed tropical north as well as marine parks. The south-west has the greatest economic activity, population, infrastructure and CALM presence. It would seem to command the largest proportion of research resources. However, it could

be argued that the less disturbed tropical north, arid interior and marine parks warrant generous research investment to establish sound management practices while they remain relatively undisturbed. On balance it seems appropriate that the south west take the largest share of resources, but that research input to other areas be disproportionate to their present level of development. In particular there should be a commitment to undertake survey/monitoring work in these areas. The absence of CALM management presence may make more elaborate work than this difficult to sustain.

#### **Research relating to CALM lands vs other lands**

CALM has responsibilities for conservation and timber production which extend beyond the boundaries of CALM land. Also activities outside CALM lands may have direct impacts within them e.g. hydrological impacts including salinity and nutrient enrichment may be felt in drainage systems and wetlands at great distance from the disturbance; likewise feral animals, weeds and fire do not recognize the boundaries of land tenure. CALM clearly has an interest in sound land use beyond its boundaries and research priorities should reflect this.

#### **Public and political factors in priority setting**

Many issues in CALM research are of high public concern. Such issues may become political and pressure may grow for specific research to be undertaken. This may be a problem where the application of the internal priority setting process indicates that the issue is of low priority, particularly if no new resources are forthcoming. CALM has an interest in seeing that the public and political processes that may impose research priorities do so with the best available information so that the outcome is soundly based. Internal CALM debate on research priority should be open and attempt systematically to reach a sound consensus position which is effectively conveyed to the public arena to guide informed public debate.

#### **Inertia in existing commitments in physical resources and staff**

Priorities which involve major relocation of physical and staff resources cannot be summarily introduced. The meeting of such priorities requires longer term planning extending beyond the 5 year term. Such

planning should be integrated with the planning of staff appointments, staff training, buildings and other facilities, as well as with other CALM planning.

## **EXPLICIT CRITERIA FOR PRIORITY ALLOCATION**

For ease of use, criteria are arranged into categories depending on the level of research to which they apply. They are also arranged in order of importance within each category.

### **GENERALLY APPLICABLE CRITERIA**

#### *Relevance*

Research must be relevant to CALM's goals and objectives as enumerated in legislation and the Department's Corporate Plan.

#### *Departmental Priorities*

Research priorities will reflect overall Departmental priorities as laid down by the Policy Directorate.

#### *Cost effectiveness*

Research should lead to substantial improvement in the economics of management on CALM lands.

#### *Scale of the problem*

The research should relate to a problem (or problems) afflicting extensive areas or important industries, or important species, or many ecosystems, and be of long duration or intensive in impact.

#### *Demand for results*

The information is, or will be, sought urgently by managers.

#### *Spread of research activity*

It is desirable that some research presence is achieved in all major CALM lands, so as to develop expertise, provide surveillance and respond rapidly in the event of any major problem emerging.

#### *Linking funding to performance*

Work proposed by individuals or programs with a record of outstanding achievement will be favoured.

#### *Innovation potential*

Some high risk or speculative research will be approved where there is sufficient promise of radical advance.

#### *Efficient use of staff expertise*

New research to be undertaken will be constrained by the expertise of the individual available to lead that research. Likewise, some lower priority projects may be undertaken to utilize fully the skills available.

#### *Matters of high public concern*

A capacity to respond to soundly based public concern must be maintained.

#### *Integration with research outside CALM*

Research within CALM will be co-ordinated and integrated with related work being conducted by other agencies. Other matters being equal, higher priority will be given to programs/projects which augment or stimulate relevant external research.

#### *Outside funding*

The availability of external funding may elevate the priority rating of any research project. However, high priority research should not be delayed or displaced by the need to support partly externally funded low priority work. Gaining external funds must not be a reason for withdrawing internal funds from any individual or program.

### **ADDITIONAL CRITERIA FOR RANKING PROJECTS**

#### *Experimental approach*

A majority of projects should be experimental so as to identify cause and effect rather than be documentary or descriptive.



*Project design*

Extremes of experimental treatments should be examined.

**CRITERIA FOR TERMINATING PROJECTS**

*Completion*

The project is complete and the conclusions have been implemented by Operations.

*Failure*

The project does not look like producing anything of value.

*Insufficient resources*

Resources do not now allow successful completion of the project.

*Irrelevance*

The project is no longer relevant because of changing policies or external factors.

## **PART 5**

## **ALLOCATION OF RESOURCES**

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### **REALLOCATION OF EXISTING RESOURCES**

In the light of Departmental priorities, the need to reallocate resources from one area of research to another will arise during the period of this plan. However, there will not be a sudden shift of resources and, by and large, existing resource allocations are likely to stand until the completion of a project unless there are grounds for early termination (see Part 4) or there are significant overriding reasons for the transfer of resources to new projects.

Where priorities dictate the transfer of resources from one program to another, this will be achieved by:

Reviewing all staff and wages items that become vacant.

Reviewing the allocation of staff when major research projects are completed.

Reviewing the allocation of financial resources each financial year.

Reviewing each Program at least every three years as from 1990.

The review process will involve a consideration of the criteria listed in Part 4. In addition, development of priorities for the Department as a whole will enable the Research Division to better decide on its own priorities.

Although the Division is involved with an extremely wide array of problems, many other areas of concern are not formally addressed at present. So that emerging problems can be quickly identified the Research Division has prepared a list of staff who have or could develop expertise in a variety of subjects (Appendix III). These persons will be asked to maintain a watching brief on particular areas and alert the Director of Research to any problems that arise that may need research or management.

### **REVIEW OF RESEARCH PROGRAMS**

Some resource reallocation within and between programs will also be achieved during reviews of

each program. An initial review took place early in 1988. Following these reviews more detailed reviews will occur approximately every three years. These reviews will be carried out by Review Committees specially set up for that purpose. Each committee will consist of about three persons, plus the Program Leader, and will be chaired by the Director of Research. Members may come from Research Division, from the Policy Directorate, other Divisions or from outside the Department, as appropriate.

### **PRIORITIES FOR NEW RESOURCES**

Recognizing the limited resources that are available to CALM, the Research Division Policy Group in March 1989 reviewed priorities for the allocation of staff and resources within the Division, should a vacancy occur. Growth areas were prioritized as follows:

1. Marine Conservation
2. Flora Conservation
3. Herbarium Data Base
4. Environmental Weeds
5. Herbarium Collections

When allocating priorities it is important that the proposals dovetail with the latest trends set for the functions of the Department as a whole.

### **STAFF MOVEMENTS AND APPOINTMENTS**

Thirteen (five professional and eight technical and clerical) officers joined the permanent staff of the Division in 1988/89. Seven permanent officers left the Division by way of internal transfer or promotion during the period. Four officers resigned.

The Department partly funded Research Scientist, Geoff Stoneman, to study full-time for a PhD degree. This study leave commenced in April 1989 and extends for a three year term. Dr Stuart Crombie has been appointed to the resulting vacancy.

## **New Appointments 1988/89**

### Professional

J. Armstrong - Senior Principal Research Scientist and Curator, Herbarium  
N. Gibson - Research Scientist  
J. Pigott - Research Scientist  
J. Stoddart - Senior Research Scientist  
S. Van Leeuwen - Research Scientist

### Technical and Clerical

S. Curry - Technical Officer  
J. Gardner - Technical Officer  
G. Godfrey - Clerical Officer  
J. Healey - Clerical Officer  
M. Langley - Technical Officer  
M. Lyons - Technical Officer  
J. Scott - Administrative Assistant  
N. Thomas - Technical Officer

### **Departures 1988/89 (transfers, promotions and resignations)**

### Professional

P. Brown - Research Scientist  
A. Thomson - Research Scientist  
J. Tippett - Senior Research Scientist

### Technical and Clerical

S. Bellgard - Technical Officer  
J. Bopp - Technical Officer  
W. Frost - Technical Officer  
G. Maranta - Clerical Officer  
C. Mathews - Administrative Assistant  
L. Simmonds - Clerical Officer  
P. Walsh - Technical Officer  
M. Wilke - Clerical Officer

### **Movements Between Research Centres**

Some minor movement of staff between country and metropolitan Research Centres occurred during 1988/89. Staff can be moved in order to facilitate the works program and bring them closer to study sites. Career development is seen as a major criterion for moving more junior research staff. Availability of office and laboratory accommodation is also viewed when considering any move.

During 1988/89 the following movements of staff between research locations occurred:

G. Brennan (Research Scientist) from Bunbury to Harvey

N. Burrows (Senior Research Scientist) from Woodvale to Como

D. Pearson (Research Scientist) from Kalgoorlie to Woodvale.

## PART 6

## GEOGRAPHICAL DISTRIBUTION OF RESEARCH EFFORT

Research effort is spread throughout the State. Table 6 indicates the % time spent on research in each of the eleven CALM regions and interstate. Note that the Executive and Administrative Support,

Research Computing and Research Methods Programs are not included in Table 6, as they are service programs.

**Table 6**  
**Geographical Distribution of Research by Programs 1988/89**

### Index

1 = KIMBERLEY  
2 = PILBARA  
3 = GASCOYNE  
4 = GOLDFIELDS  
5 = GREENOUGH  
6 = WHEATBELT

7 = METROPOLITAN  
8 = NORTHERN FOREST  
9 = CENTRAL FOREST  
10 = SOUTHERN FOREST  
11 = SOUTH COAST  
12 = INTERSTATE

PROGRAM	1	2	3	4	5	6	7	8	9	10	11	12
BIOGEOGRAPHY	56.0	3.0	-	5.0	1.0	2.0	1.0	11.0	2.0	10.0	9.0	-
ENTOMOLOGY	-	-	-	-	-	5.0	2.0	2.0	41.0	40.0	10.0	-
FAUNA CONSERVATION	15.0	6.0	9.0	4.0	25.0	19.0	2.0	1.0	-	8.0	11.0	-
FIRE	-	4.0	-	28.0	2.5	11.0	-	2.5	0.5	23.5	28.0	-
FLORA CONSERVATION	-	5.0	-	7.0	18.0	24.0	5.0	11.0	3.0	6.0	21.0	-
HERBARIUM	25.0	5.0	5.0	7.0	8.0	9.5	5.5	5.0	5.5	6.0	9.5	9.0*
MARINE CONSERVATION	-	5.0	50.0	-	5.0	0	40.0	-	-	-	-	-
PLANT DISEASES	-	-	-	-	0.3	-	19.0	59.0	12.0	2.0	7.7	-
REHABILITATION	-	-	-	3.0	-	11.0	-	9.0	30.0	19.0	28.0	-
SILVICULTURE	-	-	-	-	-	-	-	38.0	40.0	21.0	1.0	-
WETLANDS & WATERBIRDS	4.5	-	4.0	0.5	20.0	8.0	12.0	25.0	10.0	8.0	8.0	-
WOOD UTILIZATION	-	-	-	-	-	-	-	30.0	37.0	33.0	-	-

\* Work by Herbarium staff on plants outside Western Australia is counterbalanced by work by botanists in other States on the Western Australia flora.

Research Division staff came from three different organizations, each of which applied different titles to their professional and non-professional staff. Furthermore there were considerable differences in the terms and conditions of employment in the former agencies, particularly for Technical staff.

The RDPG is committed to bringing titles and working conditions into a single, Division-wide system. Substantial progress was made during 1988/89 but the process is slow because many industrial issues need to be agreed by all parties within CALM and, in many instances, by other Departments that have staff employed under the same awards and by the Public Service Commission.

### **PROFESSIONAL STAFF**

All professional officers are Scientific Officers bearing the title "Research Scientist" except Herbarium professionals, who (because the Herbarium was part of the Department of Agriculture) are Agricultural Scientists bearing the title "Botanist". This issue will be addressed when Criteria Progression beyond Level 6 for Scientific Officers has been resolved.

All professional officers can be promoted under the principals of "Criteria Progression". For many years Agricultural Scientists have had criteria progression opportunities to Levels 7 and 8. However Scientific Officers are still only able to progress by this system to Level 6.

The Public Service Commission has agreed to extend Criteria Progression to Level 7 and 8 for Scientific Officers and is considering criteria similar to those applied to Agricultural Scientist and agreed to by a working group representing Departments employing Scientific Officers.

### **TECHNICAL STAFF**

The role of Technical staff is critical to the functioning of the Division. These staff, more than anyone, are the "doing" people. They set out and organize field work, collect data, organize it and at higher levels assist with analysis and write up as well as putting results into practice. Basically their task is to assist Research Scientists, not to do their job for them.

Some technical staff are employed under the Public Service Act. Others are employed under the CALM Act. The difference is due to the amalgamation of groups from different backgrounds into the Research Division. This situation has resulted in problems because the terms and conditions of employment are not the same.

The Division's aim is to have all technical staff employed under one Act, the Public Service Act. Some CALM Act officers have expressed a desire not to change. Pending resolution of this issue, the following actions are in place to secure uniform terms of employment within the Division and effect the stated aim.

- The terms and conditions of employment of CALM Act officers are being brought into line with the Public Service Act officers, including commuted overtime and annual leave provisions and criteria progression opportunities to Level 4. Most issues are resolved.
- All vacancies not filled by internal transfers will be advertised as Public Service positions.
- All positions now carry the titles "Technical Officer" or "Senior Technical Officer".

Until recently most CALM Act Technical staff have joined research as Cadet graduates on Level 1. However the Department will no longer allocate graduates to the Division. In future all Technical staff vacancies will be filled by internal transfer or advertisement at a base classification of Level 2. The Division will not employ any more technical staff at Level 1.

The RDPG is proposing to alleviate the pressures of some Research Scientists who also act as Research Centre Managers by developing Level 5 Centre Manager positions which would be available to suitably qualified technical staff. This will improve the effectiveness of more senior staff as well as enhancing career opportunities for Technical Officers.

### **ADMINISTRATIVE SUPPORT STAFF**

At present five units requiring administrative support can be identified: Division; Large Research Centres (Como, Woodvale, Herbarium); Research Centres

(Manjimup, Dwellingup, Busselton); Research Stations (Collie, Narrogin, Karratha, Wanneroo) and RDPG.

### Division

The 1988/89 edition of this plan foreshadowed creation of a position at Level 4 for a Divisional Administrative Officer. However the proposal was not approved by the Public Service Commission. At present the Administrative Officer to the RDPG provides Division-wide support in Staffing matters and the Administrative Officer, Como Research Centre, oversees financial management at this level.

### Large Research Centres (LRC)

Administrative structures already exist but are not co-ordinated between centres. There is no recognized formula for administrative structure.

RDPG considers that LRC administrative staffing structure should be O.I.C. Administrative Officer L3, Assistant Administrative Officer/Typist L2 and Clerk Typists L1. (The number of Clerk Typists to be determined by work loads, but normally 2 unless more are warranted).

### Research Centres (RC)

Comments as for LRC

RDPG considers that RC administrative staffing structure should be O.I.C. Assistant Administrative Officer L2 and Typist L1.

### Research Stations

Research Stations are normally attached to operations bases. Each is administered as an

extension of a Research Centre where Divisional matters (e.g. budget) are concerned. Other support (e.g. typing) is provided by the Region or District.

RDPG considers that the *status quo* be maintained.

### RDPG

The RDPG workload requires administrative support. It is not appropriate that it be built into Research Centre administrative structures because the issues are not confined to particular centres.

The RDPG administrative structure should be an Administrative Officer L3, and a Clerk Typist Level 2.

### Summary

With the present structure of Research Centres the administrative and clerical requirements are:

- L3 3 Administrative Officers
- L2 3 Assistant Administrative Officers
- L2 4 Assistant Administrative Officers/Typists
- L1 10 Clerk/Typists (assuming 2 each at Como and Woodvale).

The RDPG strongly believes that, as most staff now have access to personal computers with word-processing programs, officers should increasingly undertake their own typing. This will enable the division to utilize its scarce FTE resources on research, not support.

## PART 8

## SCIENTIFIC PAPERS APPROVED FOR PUBLICATION

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The following scientific papers were approved for publication during 1988/89. Further details on these papers can be obtained direct from the authors.

### BIOGEOGRAPHY

Burbidge, A.A., Dixon, K.W., and Fuller, P.J. Nature conservation values of vacant Crown land at White Wells, Shire of Dalwallinu, W.A.

Hopper, S.D., and Burbidge, A.H., Conservation status of Banksia Woodlands on the Swan Coastal Plain.

Keighery, G.J., Brown, J. and Keighery, B.J. Vegetation and Flora of Bold Park, Perth.

Morris, K.D. Management proposals for the Monte Bello Islands and surrounding waters.

### FAUNA CONSERVATION

Burbidge, A.A. and Friend, J.A. Back from extinction.

Burbidge, A.A. and Fuller, P.J. Numbers of breeding seabirds on Pelsaert Island, Houtman Abrolhos, W.A.

Burbidge, A.A. and Fuller, P.J. On the vernacular name of *Petrogale burbidgei*.

Burbidge, A.A. and McKenzie, N.L. Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications.

Burbidge, A.A. and Smith, G.T. Noisy Scrub-bird RAOU list of rare, endangered and extinct birds.

Friend, J.A. Saving the Numbat.

Friend, J.A. The numbat *Myrmecobius fasciatus* (Myrmecobiidae). History of decline and potential for recovery.

Morris, K.D. Conservation of the Shark Bay Mouse *Pseudomys praeconis*.

Start, A.N. and Morris, K.D. White-breasted form of the wedge-tailed Shearwater, *Puffinus pacificus* off the Pilbara Coast.

### FIRE

Burrows, N.D. and McCaw, W.L. Fire studies in Banksia low woodlands in Western Australia. Fuel characteristics.

Burrows, N.D. and Sneewjagt, R.J. McArthur's Forest Fire Danger Meter and the Forest Fire Behaviour Tables for Western Australia; Derivation, applications and limitations.

Burrows, N.D. and Van Didden, G. Aerial patch burning in the Gibson Desert Nature Reserve.

Hopkins, A.J.M. and Griffin, E.A. Fire in the *Banksia* woodlands of the Swan Coastal Plain.

McCaw, L.W. Measurement of fuel quantity and structure for bushfire research and management.

McCaw, L.W. and Burrows, N.D. Fire studies in Banksia Woodland in W.A.

Walsh, P.H. and Burrows, N.D. Firebase: a computer system for storing, retrieving and manipulating forest wildfire data.

Ward, B. and Burrows, N.D. The contribution of bark on standing trees to fuel weight in Jarrah/Marri forests.

### FLORA CONSERVATION

Hopper, S.D. and Coates, D.J. Conservation of genetic resources in Australia's flora and fauna.

Keighery, G.J. Pollination of *Hibbertia conspicua* (Dilleniaceae).

Keighery, G.J. Banksia woodland weeds.

Keighery, G.J. Biology of *Schoenus capillifolius* (Cyperaceae). A rare and unusual sedge.

## HERBARIUM

Brooker, M.I.H. and Hopper, S.D. A taxonomic revision of *Eucalyptus wandoo*, *E. redunca*, and allied species (*E. series Levispermae* - Myrtaceae) in Western Australia.

Keighery, G.J. A new species of *Patersonia* (Iridaceae) from south Western Australia.

Keighery G.J. Taxonomy of the *Grevillea brachystylis* species complex (Proteaceae).

Keighery, G.J. *Caesia viscida* Keighery a new species of Anthericaceae (Liliaceae s.l.) from south Western Australia.

Keighery, G.J. *Psammomya* (Cellastraceae); A taxonomic review.

Kenneally, K. *Grevillea donaldiana* (Proteaceae), a new species from the Kimberley Division of W.A.

Lander, N.S. New species of *Olearia* Moench (Asteraceae) *Astereae* endemic to Western Australia.

Lander, N.S. The Tasmanian plant collecting localities of Ronald Gunn and Joseph Mulligan - additional records.

Lander, N.S. *Apostates*, a new genus of Asteraceae (*Astereae*) from the south eastern Polynesian islands of Rapa.

Maslin, B.R. *Acacia veronica* Maslin (Leguminosae mimosoideae), a new species of *Acacia* endemic in the Stirling Range, W.A.

Rye, B.L. A new species of *Pimelea* (Thymelaeaceae) from south-western Australia.

Semenuik, C.A., Semenuik, V., Cresswell, I.D. and Marchant, N.G. A proposed descriptive classification for wetland vegetation of the Darling system.

Wheeler, J. A new species of *Hibbertia* (Dilleniaceae) from the Kimberley Region.

## PLANT DISEASES

Crombie, S.D. Transpiration of *Eucalyptus marginata* Donn. ex Smith and its associated understorey on deep soils during summer drought.

Crombie, S.D. and Tippett, J. Water relations and symptom expression in *Eucalyptus marginata* infected by *Phytophthora cinnamomi*.

Davison, E.M. The importance of *Phytophthora* in indigenous forests in Australia.

## REHABILITATION

Moore, R., and Russell, R. The "Three Norths" Forest Protection System - China.

## RESEARCH METHODS

Ward, D. Monitoring community attrition.

Ward, D. Ecological Question Maps.

## SILVICULTURE

Whitford, K. Estimating the leaf area of jarrah trees with allometric equations.

## WETLANDS AND WATERBIRDS

Halse, S. Wetlands of the Swan Coastal Plain, past and present.

## WOOD UTILIZATION

Brennan, G.K. Seasoning 25 mm mature jarrah boards using a progressive tunnel kiln.

Siamos, L. and Siemon, G.R. Effect of pencilling and furnace of oil treatment on strength properties of jarrah.

## OTHER

Brown, P. Davison, E. and Hussey, P. (editors). Tree Decline and revegetation newsletter.

Hopkins, A.J.M. Establishment of a Departmental monitoring program.



## PART 9

## SEMINARS PRESENTED BY RESEARCH AND ASSOCIATED STAFF 1988/89

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During 1988/89 seventeen seminars were organized and presented by Research Division and associated staff. Seminar presentations are designed to disseminate information and stimulate discussion

and are open to all CALM staff, tertiary institutions, other research organizations and interested members of the public. The following seminars were presented during the fiscal year:

Scientist	Topic
A.A. Burbidge	Contributions of islands to mammal conservation in Australia.
A.H. Burbidge	Biological survey of Yanchep National Park: how was it useful.
N.D. Burrows	Fire behaviour modelling in hummock grasslands. Aero patch burning in desert reserves.
D.S. Crombie	Plant physiology as a quiet tool for CALM managers.
E.M. Davison/B.L. Shearer	The importance of <i>Phytophthora</i> in indigenous forests in Australia.
J.D. Farr	<i>Uraba lugens</i> in South Australia: biology and performance in relation to nitrogen nutrition.
G.R. Friend	Ecology of the Black-footed Tree-rat in the Kimberley and Top End of the Northern Territory.
S.A. Halse	Wetlands of international importance - background and wetlands nominated.
S.D. Hopper	Species complexes, concepts and conservation in W.A. spider orchids ( <i>Caladenia</i> ).
J.F. McGrath	Influence of nitrogen supply on <i>Pinus radiata</i> growth and the development of water stress.
R.W. Moore	The development of farming systems with trees to control land degradation and to produce timber.
K.D. Morris	The distribution status and breeding biology of marine turtles along the North-west coast of W.A.
B.L. Rye	The taxonomy of the Thymelaeaceae ( <i>Pimelea</i> family).
G.R. Siemon	The small eucalypt processing study: a mid-term report.
G.L. Stoneman	Silviculture for water production in the Northern Jarrah Forrest.
R.J. Underwood	The implementation of CALM's Fire Policy.
D.J. Ward	The Ecocube and enquiry mapping: tools for planning of ecological research?
D.J. Ward	The use of triangles for assessing the density of plants, animals and little wiggly things.
R.T. Wills	An initial appraisal of the impact of dieback on plant communities of the Stirling Range.

## PART 10

## NEW RESEARCH PROJECTS

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The following new Research Project Plans were approved during 1988/89. Information on these

research projects can be obtained from the principal investigator.

RPP No.	Title	Principal Investigator
<u>Biogeography</u>		
44/88	Edaphic climatic and floristic pattern associated with the distribution of three species of forest Eucalypts restricted to the Walpole area of S.W. Australia.	G. Wardell-Johnson
<u>Entomology</u>		
39/88	Survival of <i>Uraba lugens</i> Walk on different food plant and species.	J. Farr
41/88	Fecundity of <i>Uraba lugens</i> in relation to pupal mass.	J. Farr
42/88	Spatial distribution of <i>Uraba lugens</i> pupae in relation to its Jarrah host.	J. Farr
<u>Fire</u>		
47/88	Fire behaviour in hummock grasslands	N. Burrows
61/88	Fire studies in shrubland at Stirling Range National Park. Part 1 - Fire Behaviour	L. McCaw
62/88	Fire studies in shrubland at Stirling Range National Park. Part 2 - Vegetation response to fire.	L. McCaw
1/89	Regeneration of vascular plants of the Walpole-Nornalup National Park (A flowering calendar for the Walpole-Nornalup National Park).	G. Wardell-Johnson
<u>Plant Diseases</u>		
40/88	Survey of pathogens of <i>Pinus radiata</i> in the Blackwood Valley.	E. Davison
46/88	Brown wood in Karri.	E. Davison
55/88	Identification of Eucalypt canker fungi.	E. Davison
56/88	Water relations and growth of jarrah on high, moderate and low impact dieback ( <i>Phytophthora cinnamomi</i> ) sites.	S. Crombie
57/88	Water relations of jarrah ground coppice, stump coppice and trees.	S. Crombie
5/89	Seasonality and sporulation of <i>Phytophthora cinnamomi</i> in mining operation soils.	B. Shearer/B. Morgan
6/89	Survival of <i>Phytophthora cinnamomi</i> encysted zoospores in ALCOA mining operation soils.	B. Shearer/B. Morgan
8/89	Effect of canopy density of soil temperature in relation to <i>Phytophthora cinnamomi</i> activity.	B. Shearer/J. Kinal
<u>Rehabilitation</u>		
58/88	Windbreak studies on the south coast sandplain - Young <i>Pinus radiata</i> windbreak growth and management monitoring.	D. Bicknell
59/88	Coppicing mature <i>Eucalyptus cladocalyx</i> (Sugar Gums) and <i>Eucalyptus gomphocephala</i> (Tuart) in windbreaks on the Esperance sandplain.	D. Bicknell

RRP No.	Title	Principal Investigator
60/88	Windbreak studies on the south coast sandplain - Young <i>Pinus radiata</i> windbreak affect on annual crop growth and yield.	D. Bicknell.
<u>Silviculture</u>		
43/88	Blackwood Valley Pine drought death survey.	J. McGrath
48/88	<i>Eucalyptus microcarpa</i> provenance trials.	T. Birmingham
53/88	<i>Eucalyptus muellerana</i> family/provenance trials.	R. Mazanec
54/88	<i>Eucalyptus muellerana</i> family/provenance trials.	R. Mazanec
64/88	Low rainfall special trial.	T. Birmingham
3/89	Effect of thinning and fertilizing on the growth and form of crop trees in a 21 year old stand of karri regrowth of community type Stoate.	P. Hewett
7/89	Southern jarrah family provenance trials.	R. Mazanec
9/89	A trial measurement of a catchment leaf area index (LAI) using hemispherical photography.	K. Whitford
10/89	Survey of the genetic structure of the main range jarrah forest using isozymes.	R. Mazanec
11/89	<i>Eucalyptus botryoides</i> family provenance trials.	R. Mazanec
13/89	Shelter cap sowing of <i>E. diversicolor</i> (F. Muell.) seed in regeneration coupes.	P. Hewett
15/89	Thinning and fertilizing regimes for 13 year old <i>Pinus taeda</i> on the Donnybrook Sunklands.	J. McGrath
17/89	Effect of fertilizer on successful regeneration of <i>E. marginata</i> using broadcast seeding and mechanical disturbance.	P. Hewett
<u>Wood Utilization</u>		
9/86	Extension to Lyctus study.	G. Brennan
45/88	An assessment of the use of edge jointed regrowth jarrah panels for furniture manufacture.	D. Challis
49/88	Processing - stability of regrowth jarrah panels constructed from boards of differing moisture content.	P. Newby
50/88	Processing - stability of regrowth jarrah panels under differing equilibrium moisture contents.	P. Newby
51/88	Processing - compare the WURC grade rules to the US rules and specifications, using dry dressed regrowth jarrah boards.	P. Newby
52/88	Processing - Edge and face jointing regrowth jarrah boards into panels.	P. Newby
65/88	Evaluate growth Eucalypt log degrade after six months storage continuous waterspray using two systems e.g. high pressure high volume knocker type sprinkler and low pressure low volume black poly pipe soaker system.	K. White
4/89	Sawn graded recoveries from a sawmilling trial of regrowth jarrah and karri.	K. White/S. Raper
14/89	Field survey of the incidence of brown wood in regrowth karri.	E. Davison

## **PART 11**

# **AIM AND PRIMARY OBJECTIVES OF RESEARCH DIVISION**

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### **OVERALL AIM**

To develop a scientific basis for conservation and land management in Western Australia by conducting research and providing expert advice.

### **OVERALL PRIMARY OBJECTIVES**

#### **Conservation Of Biological Resources**

To provide the scientific basis for the conservation of indigenous plant and animal species, ecosystems and natural processes in natural habitats throughout the State.

To provide and maintain a plant taxonomic and a biogeographical data base of the plants, animals and ecosystems of Western Australia and to develop an understanding of the factors that cause changes in their distribution and abundance.

#### **Management Of Biological Resources**

To apply research findings and, in conjunction with Operations staff, develop, test and implement techniques that can be used to better manage plant and animal populations and lands and waters entrusted to the Department.

To provide the scientific basis for the production and regulation of the supply of those renewable

resources that Government decides should be used, on a sustained yield basis and in a manner that minimizes impact on other values

#### **Ecology**

To develop an understanding of the interactions between populations, species, communities and their environments and develop appropriate ecological theories.

#### **W.A. Herbarium**

To preserve, curate and extend the State's principal reference collection of native and naturalized plants and to conduct and assist plant taxonomic research in order to provide authoritative names and other taxonomic information essential for effective conservation and management of the flora.

#### **Communication And Advice**

To communicate and provide expert advice on results of research effectively by production of scientific, technical and educational publications, input into the land management planning process, preparation of Wildlife Management Programs, liaison with other CALM staff, other Departments and the public, involvement with scientific and other conferences and by any other means available.

## PART 12

## THE PROGRAMS

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Each of the 15 programs has, as far as practicable, a common format, as follows:

### PROGRAM LEADER

### CURRENT RESOURCES (1989/90) AND RESOURCES IN THE PREVIOUS YEAR (1988-89).

Normal research administration (i.e. supervision of staff, preparation of grant applications, committee meetings) is included here. However time spent by a scientist as Program Leader, Research Centre Manager, or as a member of RDPG is only included in the Executive and Administrative Support Program. The allocation of each member of Research Division to these Programs is itemized in Appendix I. Figures on financial support for 1989/90 are estimated figures only.

### BACKGROUND

This provides a brief introduction to the scope and role of the Program. Major current gaps in knowledge are outlined.

### ACHIEVEMENTS

This highlights the major accomplishments of the Program over the past twelve months.

### AIM

This states what the Program should have achieved by 1994. It is a one-sentence statement of mission.

### PRIMARY OBJECTIVES

These are in priority order, which normally entails a logical sequence in that the first objective is needed before the second one can be properly addressed. They are sufficiently general not to favour any one approach or solution. Although Primary Objectives often read like omnibus statements, they are fundamental to the structure of each Program. New projects suggested by members of a Program are always compared with the Primary Objectives of the

Program. If they do not fit, they will not be approved.

### 20 YEAR GOALS

These are based on current resources and are in priority order. Asterisks are used to show the relative importance of each goal.

### 5 YEAR GOALS

These are written specifically, so that at the conclusion of 5 years it will be possible to assess whether each goal was achieved. These goals are subsets of the Primary Objectives and follow the sequence used for them. Care has to be taken to make these goals intelligible to non-scientists.

### PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994.

These are summarized from the Table accompanying each Program

### PROPOSED NEW PROJECTS - WITH ADDITIONAL RESOURCES (IN PRIORITY ORDER).

These are summarized from the same Table.

### PUBLICATIONS AND REPORTS 1988/89.

Publications in scientific journals have been marked with an asterisk. Papers in press are not included. They will be recorded as publications in the next edition of this plan.

### THE TABLE

This shows the relation of all research projects to the 5 Year Goals and the Primary Objectives. The full title of all RPPs (Research Project Plans or their antecedents) is listed in Appendix II of this Plan. The specific work done on each RPP between July 1988 and June 1989 is summarized. The column entitled Targets 1989-90 is intended to convey in a telegraphic style the works program for the period July 1989 - June 1990.

# EXECUTIVE & ADMINISTRATIVE SUPPORT PROGRAM

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## PROGRAM LEADER

AA Burbidge

## CURRENT RESOURCES 1989/90

This program comprises 25 persons (6.55 Professional and 17.45 Technical and Clerical and 1 contract Clerical). Its estimated CRF budget is \$1 385 968 (including \$874 563 salaries and \$511 405 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 22.65 persons (5.15 Professional and 16.50 Technical and Clerical and 1 contract Clerical). Its budget was \$991 152 (including \$614 945 salaries and \$376 207 operating costs). External funds totalled \$17 700 (salary) during the period.

## BACKGROUND

This service program is responsible for the direction and administration of all activities within Research Division.

The program can be divided into two main parts. The first consists of the Research Division Policy Group (RDPG), which is responsible through the Director of Research to the General Manager for the overall leadership and direction of the Division. The second includes the Research Centre Managers and the administrative and clerical staff who administer the day to day running of the Division.

The Program was reviewed by RDPG in April 1989 and some modifications were made to the duties of RDPG members (see Part 2).

The 20 year goals and 5 year goals of RDPG members and the Scientific Editor are set out below. All members of RDPG are expected to commit a proportion of their time to carrying out research.

## ACHIEVEMENTS

During 1988/89 the Program concentrated on three main areas: bringing all staff into the same titles, awards and conditions; improving financial management and reporting; and reviewing the

efficiency of and organization of Research Programs and the Research Division Policy Group (RDPG).

Considerable progress (see Part 7) has now been made towards achieving a uniform system of titles, conditions and awards. Account numbers and expenditure reporting systems were revised so that Program Leaders and the RDPG are better able to control expenditure. The Executive and Administrative Support Program was reviewed by RDPG in March 1989, resulting in some changes in duties and responsibilities of senior staff.

## AIM

To direct, lead and administer Research Division.

## PRIMARY OBJECTIVES

### Executive Leadership

Through RDPG, to direct and lead the Division. To coordinate multi-program research and cooperative research with external organizations. To allocate resources provided to the Division according to the Five Year Plan and Departmental changes in priorities. To oversee scientific publishing.

### Policy Development

To develop, in association with the Department's Policy Directorate and other senior staff, priorities for research. To ensure that research is carried out according to approved plans.

### Motivation & Morale

To motivate and inspire all research scientists in the Division. To assist in the development of scientific skills of inexperienced scientists in the Division. To ensure that all scientists are working to capacity and that their research is conducted efficiently and effectively.

### Administration

To administer the day to day operations of the Division through Research Centre Managers and administrative and clerical staff.

## Communication

To ensure that research is accurately applied and rapidly and effectively communicated to users.

### **DIRECTOR OF RESEARCH - A.A. BURBIDGE**

#### **20 YEAR GOALS**

1. Provide overall direction and leadership to Research Division.
2. Ensure that Research Division is an effective and efficient part of the Department and that as far as possible it meets the demands of the Department and the community for scientific information on conservation and land management.
3. Provide as far as possible the resources to enable the Division to meet its Overall Aim and Primary Objectives.
4. Through membership of Policy Directorate, contribute to the development of Departmental policies based on scientific information provided by the Division.

#### **5 YEAR GOALS**

1. Chair the Research Division Policy Group and ensure that it is an effective mechanism for promoting corporate leadership and decision-making.
2. Through Research Centre Managers and administrative and clerical staff, administer the day-to-day operations of the Division.
3. Ensure as far as possible that the Division's staff are provided with an environment where high quality scientific research can take place. Such an environment should allow and encourage scientific excellence and allow priority setting to occur in a spirit of co-operative peer review.
4. With the assistance of the RDPG ensure that research carried out by the Division is of the highest standard and is published.
5. With the assistance of the RDPG, ensure that research carried out by the Division is applied by the Department.

6. With the assistance of the RDPG, oversee the recruitment, training and development of the Division's staff.

7. Carry out other duties as directed by the General Manager or the Executive Director.

### **SENIOR PRINCIPAL RESEARCH SCIENTIST AND CURATOR, HERBARIUM - J.A. ARMSTRONG**

#### **20 YEAR GOALS**

1. Provide direction and leadership to the Herbarium, Flora Conservation and Plant Diseases Programs and ensure that the research carried out by these programs achieves a prestigious national and international scientific profile.
2. Ensure that a new and enlarged Herbarium is built in Perth and that a new research centre is built at Dwellingup.

#### **5 YEAR GOALS**

1. Encourage the Herbarium, Flora Conservation and Plant Diseases Programs to meet their 5 year objectives by judicious deployment of available resources.
2. Facilitate the development of the Herbarium's collections and improve staff accommodation by ensuring that the planned extension to the Herbarium is built.
3. Develop the Herbarium's cryptogamic collections, particularly the fungal and algal collections, to underpin the Division's research initiatives in marine conservation and plant diseases.
4. Develop, maintain and integrate the Herbarium's specimen and taxon databases with the 'Declared Rare Flora' and 'Reserve List' data of the Flora Conservation program, and to make this data more readily available.

**SENIOR PRINCIPAL RESEARCH SCIENTIST  
- P. CHRISTENSEN**

**20 YEAR GOALS**

1. Ensure that good working conditions and an *esprit de corps* are developed and maintained in the Entomology, Rehabilitation, Silviculture and Wood Utilization Research Programs.
2. Develop and foster good working relationships with other Divisions and Branches of CALM and relevant outside institutions.
3. Facilitate and co-ordinate interdisciplinary research with other Departments and Institutions.
4. Ensure that all research done in the above four programs is of high standard, is relevant to the management objectives of CALM, and when completed is put into practice as soon as possible.
5. Ensure that finances in the above programs are in good order and expenditure is controlled within budget allocations.

**5 YEAR GOALS**

1. Contribute effectively to decision-making in the Wood Utilization Research Centre, Director of Research Committee (Australian Forestry Council), Research Steering Committee, and relevant committees in the Forest Resources Division of CALM.
2. Achieve better links with a number of Branches within CALM as well as several outside institutions which are doing work relevant to the programs listed above e.g. Forest Resources Division, Inventory Branch, CSIRO, WAWA.
3. Review and re-organize the Silviculture and Rehabilitation programs to better reflect CALM priorities.
4. Institute workshops at which scientists in the above four research programs explain how their conclusions are ready for implementation by CALM managers.
5. Identify factors hampering the productivity of individual research scientists and technical staff, and arrange remedial action.

**SENIOR PRINCIPAL RESEARCH SCIENTIST  
- S.D. HOPPER**

**20 YEAR GOALS**

1. Ensure that research carried out in the Biogeography, Fauna Conservation, Fire, Marine Conservation and Wetlands and Waterbirds programs is of a high standard, is relevant to the management objectives of CALM and, when completed, is used to further the Department's goals and objectives.
2. Ensure that good working conditions and an *esprit de corps* are developed and maintained in the above programs and at the Woodvale Research Centre.
3. Ensure that resources required for research in these programs and the efficient running of Woodvale Research Centre are made available and used efficiently.
4. Develop and foster good working relationships with other Divisions and Branches of CALM as well as relevant outside institutions.
5. Effectively represent the Division and the Department.

**5 YEAR GOALS**

1. Contribute effectively to decision making by the RDPG, Working Group on Land Releases, committees associated with mining on conservation reserves and relevant CALM committees and task forces dealing with nature conservation and fire research.
2. Achieve better links with a number of branches within CALM as well as with several outside institutions that are doing work relevant to the programs listed above (e.g. CSIRO Division of Wildlife and Ecology and tertiary institutions).
3. Encourage, facilitate and provide opportunities for scientists from the programs listed above to interact with managers and planners to ensure the results of research are used to further the goals and objectives of CALM.
4. Provide opportunities and encourage scientists in the listed programs to interact with one another and with other scientists through seminars, workshops and conferences.



5. Identify and remedy factors hampering the productivity of individuals in the listed programs and at Woodvale Research Centre.
6. Ensure that the Woodvale Research Centre provides effective support for scientific research and a harmonious working environment.

**PRINCIPAL RESEARCH SCIENTIST - I. ABBOTT**

**20 YEAR GOALS**

1. Ensure that good working conditions and an *esprit de corps* are developed and maintained in the Entomology, Rehabilitation, Silviculture and Wood Utilization Research Programs.
2. Develop and foster good working relationships with other Divisions and Branches of CALM and relevant outside institutions.
3. Facilitate and co-ordinate interdisciplinary research with other Departments and Institutions in the area of our responsibility.
4. Ensure that all research done in the above four programs is of high standard, is relevant to the management objectives of CALM, and when completed is put into practice as soon as possible.
5. Ensure that finances in the above programs are in good order and expenditure is controlled within budget allocations.

**5 YEAR GOALS**

1. Ensure that scientists in the four research programs listed above publish in the best journals available.
2. Ensure that all research in the four research programs listed is carried out in accordance with approved Research Project Plans (RPPs).
3. Supervise the Research Methods program and ensure that it provides an appropriate service across Research Division.
4. Oversee scientific publishing in Research Division through chairing the Scientific Publishing Editorial Committee, and in consultation with the Scientific Editor expedite

the rate of publication of papers submitted by Divisional staff for publication in CALM journals.

5. Organize an annual series of seminars for Research Division staff.
6. Devise ways Research Division can improve dissemination of research knowledge to the public at large, school students, and the scientific community.
7. Co-ordinate the annual revision of the Research Division rolling Five Year Plan.
8. Develop and publicize methods for monitoring productivity of scientists across Research Division.

**PRINCIPAL RESEARCH SCIENTIST - T. START**

**20 YEAR GOALS**

1. Ensure that good working conditions and an *esprit de corps* is developed and maintained among all personnel in the Division.
2. Ensure that Departmental assessment of ERMPs benefits from the accumulated knowledge and stored data available within the Division.
3. Ensure that the accumulated knowledge and stored data are fully utilized by the Department in the development of Management plans and similar documents.
4. Ensure that Research Division finances are in good order and expenditure is controlled within budget allocations.

**5 YEAR GOALS**

1. Obtain parity in working conditions and salary structure throughout the Division.
2. Develop a satisfactory career structure for technical, support and scientific staff.
3. Develop a training program for research staff that is relevant to the working environment within the Division.

4. Assist and facilitate training of scientists in technology new to them and philosophies relevant to developing management-related research projects.
5. Establish a technical staff committee to assist with staff matters.
6. Develop an effective method of financial control relevant to the needs of the Division.
7. Ensure that Departmental assessment of ERMPs benefits from the accumulated knowledge and stored data available within the Division.
8. Ensure that the accumulated knowledge and stored data are fully utilized by the Department in the development of Management Plans and similar documents.

#### SCIENTIFIC EDITOR

The publication and dissemination of scientific and technical papers and reports is a major function of Research Division. Publication can be in external journals or in Departmental publications. Staff are encouraged to publish in external, refereed journals wherever possible. However, material that is not appropriate to such journals, but is of sufficient standard to be published, will continue to be produced by the Department.

Scientific publishing is overseen by the Scientific Publishing Editorial Committee (SPEC). Current membership is: Principal Research Scientist (I. Abbott), Scientific Editor, three other scientists from Research Division and a representative from Services Division.

Dr I. Abbott (Chair)  
 Ms M. Lewis (Scientific Editor) (Secretary)  
 Dr S. Crombie  
 Dr G. Friend  
 Mr N. Lander  
 Dr F. McKinnell

In 1988 Ms Lewis was transferred from Information Branch to Research Division. She spends 100% of her time on scientific publishing, including editing of publications emanating from other Divisions.

The budget allocated for scientific publishing is \$32 500 (1988/89 : \$32 500).

#### 20 YEAR GOAL

Ensure rapid dissemination through publication of scientific and technical findings.

#### 5 YEAR GOALS

1. Explain to CALM staff the purpose, scope, readership and requirements of each research and technical publication produced by the Department.
2. Edit papers for publication in Departmental Research Bulletins, Technical Reports, Occasional Papers, Wildlife Management Programs and Regional Flora Handbooks (Nuytsia and Kingia are produced by the Herbarium according to specifications in the Attachment to Policy Statement No. 5).
3. Prepare a publishing plan to minimize editorial delays and provide an efficient publishing service.
4. Establish technical standards and maintain scientific standards in collaboration with SPEC for Departmental publications.
5. Arrange graphical and design support for authors preparing research and technical publications.

#### PUBLICATIONS\* AND REPORTS 1988/89

\*Lewis, M. (1989). Guide to authors: requirements for CALM technical and scientific manuscripts presented for publication. Dept. of CALM, W.A.

# BIOGEOGRAPHY PROGRAM

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## PROGRAM LEADER

GJ Keighery

## CURRENT RESOURCES (1989/90)

This program comprises 11.15 persons (5.80 Professional + 5.35 Technical). Its estimated CRF budget is \$490 721 (including \$383 311 salaries and \$107 410 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 7.25 persons (3.65 Professional + 3.60 Technical). Its budget was \$378 172 (including \$248 612 salaries and \$129 560 operating costs).

An additional 1.4 persons were employed under the Commonwealth funded National Rainforest Survey Program, W.A. Funds attracted from this source totalled \$109 850 (\$35 000 salary and \$74 850 operating costs).

## BACKGROUND

The Biogeography Program comprises an array of staff employed to research and carry out biological surveys throughout Western Australia. The State has the diversity, and almost the size, of a continent; for most of its 23 phytogeographic districts, species distribution data are only available for a few of the more common plants and more glamorous vertebrates. Additional surveys of districts are urgently needed.

The Program's role is to document the composition of the State's biota, i.e. to describe and monitor the patterns of distribution and status of its plants and animals. By establishing and monitoring networks of benchmark quadrats, the Program seeks to identify regional changes in the species composition of the biota (as distinct from localized fluctuations). Broad-scale quantitative biogeographic data are fundamental to the land-use decisions and management responsibilities of CALM. Such data provide an explicit basis for assessing the status of species and communities and a rational basis for setting priorities among many of the tasks that confront regional managers and management researchers.

Management priorities and decisions that are influenced or determined by biogeographic data include: legislation to protect species and communities; positioning of firebreaks and facilities for human access; selection of optimum areas of land in reserve system design and other land-use decisions; searches for additional populations of particular species and for guilds or communities of interest; proposed access to reserve system for mineral exploration; setting priorities for more specific research such as manipulative experiments on populations or communities.

At present, resources (budget allocation and staff) are too small to carry out a biogeographic survey of even a single district without substantial external funding and/or staffing. Fortunately, such assistance has been, and appears to be still, readily available where common Federal/State interests occur (Nullabor, Eastern Goldfields, Rainforest Surveys). However, to provide even a minimum coverage of W.A. within the next 10 years, we will need to be able to survey each year at least two of the 23 Phytogeographic Districts recognized in W.A.

## ACHIEVEMENTS

Field work for the National Rainforest Conservation Program, and the Yanchep National Park and Cape Arid National Park surveys was completed. Reviews of the flora of the Warren District and Shark bay area were prepared for publication. Surveys of the Dampier Archipelago and the Southern Beekeepers Reserve were published. Flora lists for North West Cape, Porongurup and Torndirrup National Parks were prepared for use by Operations Staff. A review of pastoral land for conservation was undertaken, and the update of the CTCRC System 7 report was completed.

## AIM

To describe and monitor the patterns of distribution of Western Australia's plants and animals so as to maximize their effective conservation and management.

## PRIMARY OBJECTIVES

### Data Base

Through a systematic program of ecological surveys, to provide and maintain an up-to-date biogeographic data-base of site descriptions, based on a set of permanently marked "benchmark" quadrats, representative of the diversity of Western Australia's biota. The biophysical attributes recorded from each site will be used to seek biogeographic patterns across Western Australia.

### Reserve System Design and Land-use Advice

To undertake research to select, improve and maintain a system of conservation reserves that will permanently represent Western Australia's biological diversity. To provide advice on the nature conservation importance of reserves and of areas of land outside reserves.

### Management Planning

To analyse the data base to assess the conservation status of communities and species and to provide data and interpretation to planners and managers so management is carried out according to sound scientific principles. To assist with the preparation of management plans. To assess the impact on flora and fauna if particular National Parks and Nature Reserves are opened for mineral exploration or mining. To correlate available published and unpublished data and to design surveys to capture any additional data required to make such judgements.

### Broad-scale Monitoring

To measure changes in composition of the plants and animals, both exotic and native, in relation to the variety of disturbances associated with various land-use regimes. To promote improvement in land management practices.

### Communication

To communicate the results of research in the form of technical and scientific publications, educational literature, committee representation, training courses, public and scientific seminars, and through advice and liaison with their CALM staff, with other organizations and with the community at large.

## 20 YEAR GOALS (based on current resources and in priority order)

1. Extend the data base to include representation of all Phytogeographic Districts found in Western Australia and the variety of widespread land-uses that have been superimposed.\*\*\*
2. Monitor, at 10 to 15 year intervals, the sites already installed.\*\*
3. Continue small area surveys as the need arises.\*\*\*
4. Re-assess the Program's applications, approaches and methodologies in the light of:
  - i) ongoing projects to optimize sampling strategies, methodologies and the set of biophysical attributes recorded on the quadrats.\*\*
  - ii) the analysis of the second sessions of re-sampling in selected districts.\*\*
5. Undertake a major review of the biogeography of Western Australia.\*

## 5 YEAR GOALS

1. Undertake a biogeographic survey of rainforest communities in the Gardiner, Hall and Dampier Phytogeographic Districts to extend the biogeographic data base and make recommendations on reserve needs and on their conservation status and the effects of disturbances.
2. Undertake a biogeographic survey of the Irwin/Carnarvon district to improve the State-wide representation of the biogeographic data base, to extend the network of benchmark quadrats and assess reserve needs in the district, species' conservation status and the effects of disturbers on community composition.
3. Upgrade the descriptions of Eastern Goldfields sites described in the 1970's so they can be included in the biogeographic data base, and permanently mark these quadrats.
4. Undertake detailed ecological surveys at various localities (including islands and waters) of Departmental interest and responsibility in other districts, such as the wheatbelt and on the Swan Coastal Plain to assist land-use and management

planning decisions (including reserve access to mining). Examples include surveys at Dryandra, Yanchep National Park, Cape Arid National Park and on islands in the North-west (see Table for others).

5. Continue research on methodologies, especially in relation to the biophysical attributes recorded on benchmark quadrats. Which biotic groups should be recorded? What are the most appropriate: scalars? size and heterogeneity of the quadrats? sampling methodologies including the use of remote sensing and sampling invertebrates? Relevant projects are listed in the Table.
6. Publish and/or disseminate the results of surveys in a form suitable for use/interpretation in the development of the conservation reserves system and in management planning. Examples of studies still to be published include the Eastern Goldfields survey and Two Peoples Bay survey work (see Table).
7. Develop an in-house computerized system for the field entry of quadrat data, accession of extrinsic data such as those in Geographic Information Systems, for the analyses of the data sets and for the use by managers needing information.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)**

Database: 1,3,4,14-17,19-24,26,31,32,35,37

Reserve System Design and Land Use: 40,41,46,50,51,53,54

Management Planning: 62,63,67

**PROPOSED NEW PROJECT - with existing resources**

Biological survey of islands in the Shark Bay district.  
G. Keighery, K. Morris.

Biological assessment of the likely impact of mineral exploration on the D'Entrecasteaux National Park.

Neil Gibson and Mike Lyons.

**PUBLICATIONS \* AND REPORTS 1988/89**

Burbidge, A.H. and Boscacci, L.J. (1989). A spring reconnaissance survey of the flora and fauna of the Southern Beekeepers Reserve. CALM Tech. Rep. No. 22.

Forbes, S.J., Kenneally, K.F. and Aldrick, J.M. (1988). A botanical survey of Vansittart Bay and Napier Broome Bay, Northern Kimberley, Western Australia. W.Aust. Nat. 17: 129-200.

Keighery, G.J. (1988). North West Cape Flora List. 22pp.

Keighery, G.J. (1988). Checklist of the Vascular Plants of the Porongurup Range National Park. 19pp.

Keighery, G.J. (1988). Vascular Plants of Torndirrup National Park. 19pp.

Keighery, G.J. (1988). Distribution Maps of the Asteraceae of Western Australia. 86 pp.

\*Kenneally, K.F. and McKenzie, N.L. (1989). Piecing together the remnants. *Landscape* 4: 50-52.

\*Milewski, A.V. and Keighery, G.J. (1988). Vegetation and Flora - Edjudina-Menzies Study Area. Records of the Western Australian Museum. Supplement No., 31. The Biological Survey of the Eastern Goldfields of Western Australia) Part 5 pp 11-37, 76-106.

\*Morris, K.D., Start, A.N. and Christensen, L. (1988). Beyond the bomb. Montebellos in 1988. *Landscape* Vol 3: 3-7.

\*Morris, K.D. (1989). Dampier Archipelago Nature Reserves Draft Management Plan. June 1989.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
Data Base	6,7	1 Develop micro-computer entry system for survey data RS122 NL McKenzie	System up and running in various forms. Operator's manual written	Publish manual & make system available
		2 Acquire software to process and analyse survey data NL McKenzie	PATN - extended PATN memory + VAX access available	Develop further
		3 Census of Australian Plants RS92 GJ Keighery	MS submitted	Organize plant master file
		4 Atlas of W.A. Proteaceae (except <u>Banksia</u> <u>Grevillea</u> ) RS56 AJ Hopkins	Maps for 6 genera finalized	Complete
	5,6	5 Searching vs pitfall trapping in Southern Forests RWP unallocated G Wardell-Johnson	Ongoing	Ongoing
6 Sampling small ground-dwelling vertebrates RS16 AH Burbidge		No action	Analyse data	
7 Establish CALM monitoring program RS52 AJ Hopkins		Endorsed by Policy Directorate	Begin implementation	
8 Heterogeneity of Nullarbor Quadrats RS121 NL McKenzie		No progress	Analyse	
9 Automatic bat assemblage sampling RS129 NL McKenzie		Master tape of bat ultra-sounds for 20 species compiled	Opportunistic	
10 Biogeography of flora of Southern Nullarbor RS92 GJ Keighery		Toolina re-surveyed	Continue as time allows	
11 Extending the Nullarbor data-base, do the patterns change RS120 NL McKenzie		Analysis completed	Continue as time allows	
12 Biogeographic patterns versus soil attributes RS20 NL McKenzie		Field data collected and compiled by consultant	Analyse when time allows	
13 Ecol. biog. of 4 endemic forest Eucalypts RWP 44/88		Sampling commenced	Continue	
14 National Rainforest Conservation Program KF Kenneally		Wet season collecting trip completed & identification & processing of specimens collected ongoing	Complete identifications & prepare MS; visit interstate herbaria to collaborate with Dr B. Hyland (QRS)	
15 Kimberley Flora checklist KF Kenneally		Transfer of data from Prime to PC & update	Prepare MS for publication	
16 Dampierland Peninsula survey KF Kenneally		Additional fieldwork completed, specimens identified from resident collectors & added to database	Edit database & prepare MS. Additional fieldwork to consult with resident collectors. Add to photographic collection of species	
17 Vansittart Bay survey KF Kenneally		Survey report published	Completed	

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
		18 Camden Harbour Survey KF Kenneally	Preparation for proposed survey June 1990	Undertake survey in June 1990
		19 Walcott Inlet survey KF Kenneally	Updating of list from rainforest survey & add herbarium records	Prepare MS
		20 Ashmore Reef survey KF Kenneally	Additional data added	Prepare MS
		21 Mitchell Plateau survey KF Kenneally	Specimens identified & added to floristic list	Ongoing
		22 Kimberley rivers survey: WA Naturalists Club KF Kenneally	Specimens identified & added to floristic list	Prepare MS
		23 Buccaneer Archipelago KF Kenneally	Further specimens identified	Ongoing Prepare MS with AJ Hopkins
		24 Wongan Hills KF Kenneally	Additional records added to checklist. Provided floristic information to A Coates	Continue updating checklist
		25 Flora surveys of Pilbara region S Van Leeuwen	Prepare RPPS	Commence survey(s)
Data Base, Reserve System Design and Land-use Advice	5,6	26 Ground-truthing the Nullarbor data-base RS124 NL McKenzie	Paper in press	
	4,6	27 Ad hoc flora surveys of selected crown lands RS74 SD Hopper	Reports to file 1 published, 1 draft	Ongoing
		28 Walpole-Nornalup national Park survey RWP unallocated G Wardell-Johnson	Field work ongoing	Finish field work. Begin write-up
		29 Yanchep NP survey RS15, RS99 AH Burbidge	Sampling complete	Write-up
		30 Dryandra State Forest vegetation RS99 GJ Keighery	Deferred	Commence further fieldwork
		31 Boonanarring Reserve Survey RS15 RS99 AH Burbidge	In draft	Submit MS
		32 Southern Beekeepers Reserve Survey RS15 AH Burbidge	Published	
		33 North-west Islands Survey KD Morris	Thevenard: draft mgmt proposals	Regional staff to continue fieldwork
		34 Cape Arid Survey RS15, RS99 AH Burbidge	Sampling completed	Draft report
		35 Fitzgerald River NP Survey RS127 NL McKenzie (liaison)	Corrections following referees comments	Publish & incorporate quadrat data in CALM data base
	3,4,6	36 Eastern Goldfields RS121, RS122 NL McKenzie	Goldfields vertebrate data in data-base; Cell 6 in press; Cell vegetations upgraded, field studies finished	Publish Cells 6 & 8; Prepare MS of Cells 9 & 5; Put Goldfields plant data in data-base

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
	1,6	37 Rainforest Survey NL McKenzie	Wet season sampling done. Specimens identified & in data-base. Data compiled & analysed. Many of the papers as drafts	Complete drafts for publication, edit report, publish report
	2	38 Irwin/Camarvon survey RS126 GJ Keighery	Seeking funding for survey of Kalbarri National Park & off-shore islands in Shark Bay	Regional survey deferred until 1990/91
		39 Ecological catalogue of W.A. conservation reserves and proposals NL Gibson	Commence	Ongoing
Reserve system design and Land-Use Advice, Management Planning	6	40 Proposed Jibberding White Wells Reserve Survey AA Burbidge	Draft	Publish
		41 Salisbury Island Survey AA Burbidge	No progress	Publish
		42 Bucancer Archipelago Survey RS128 NL McKenzie	No progress	Compile data & maps etc for report: also RPP 23
		43 Dampier-Burrup Archipelago Survey KD Morris	Dampier mgmt plan complete. Burrup deferred	
		44 Mandora Palaeoriver/Radi Hills Survey NL McKenzie	No progress	Compile data
		45 Cooloomia Nature Reserve Survey RS75 SD Hopper	No progress	Deferred
		46 Flora Survey of Islands: Lancelin to Dongara RS94 GJ Keighery	In press	Publish
		47 Mt Leseueur Survey work RS60 AJ Hopkins	No progress	Complete draft
		48 Stirling Range & Environs flora RS95 GJ Keighery	Rare flora mapped, draft prepared	Prepare annotated flora list
		49 Dorre Island and associated Shark Bay Island survey RS141 RIT Prince	No progress	Re-sample at 15 years is due
		50 Bold Park flora survey GJ Keighery	In press	Publish
		51 Benger Swamp Flora Survey GJ Keighery	In press	Publish
		52 Tutanning Survey work RS59 AJ Hopkins	No progress	Complete draft
		53 Two Peoples Bay Survey Work RS63 AJ Hopkins	Draft completed	Publish
54 Middle Island/Recherche Survey Work RS60 AJ Hopkins	Draft completed	Publish		
55 Dampier Archipelago Survey RS132 KD Morris	Data collated	Publish		



Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
	4,6	56 Monte Bello Island Survey RS132 KD Morris	No progress	Deferred
		57 Bird Communities of Walpole-Nornalup NP (RWP unallocated) G Wardell-Johnson	Ongoing	Prepare for publication
		58 Granite outcrop plant survey SD Hopper	Several surveyed and specimens lodged in Herbarium	Ongoing
		59 Biogeography of Dugong and Seagrasses in northern W.A. RS142 RIT Prince	No progress	Complete as opportunity presents
		60 D'Entrecasteaux NP assessment N Gibson		Correlation data. Design survey
Management Planning	4,6	61 Dampier Archipelago Management Plan RS132 KD Morris	Published	
		62 Management guidelines for Monte Bello Island RS132 KD Morris	In press	
		63 Management Plan for North-west Islands KD Morris	Provide advice as requested by Protection Branch.	Ongoing
		64 Interactions of fire and site on vegetation in the Walpole-Nornalup NP RWP unallocated G Wardell-Johnson	Ongoing	Complete field work
		65 Buccaneer Archipelago Management Plan RIT Prince	Continue to collect data	Deferred
	5,6	66 Bat assemblages: disturbance and determinism RS129 NL McKenzie	In press	A wait publication
		67 Lizard litter patch guilds RS121 NL McKenzie	No progress	Continue as time allows
		68 Distribution and taxonomy of <i>Geocrinia</i> complex RWP 1/83 G Wardell-Johnson	Drafted 1 paper	Draft 2 papers
		69 Community-types in regenerating Karri RWP 9/88 G Wardell-Johnson	Field work complete. Mapping complete	Continue as opportunity allows

# ENTOMOLOGY PROGRAM

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## PROGRAM LEADER

I Abbott

## CURRENT RESOURCES (1989/90)

This program comprises 5.9 persons (1.6 Professional + 4.3 Technical). Its estimated budget is \$218 528 (including \$184 258 salaries and \$34 270 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 5.9 persons (1.6 Professional + 4.3 Technical). Its budget was \$169 328 (including \$137 058 salaries and \$32 270 operating costs).

## BACKGROUND

The entomology program was formed in 1988 as a result of a review of all resech programs. It reflects CALM's commitment to protecting its forests and woodlands from infestations of pest insects.

Although outbreaks of defoliating insects have been studied by CSIRO in the Jarrah forest since the 1960s, knowledge about their ecology and control is still insufficient. Outbreaks of Leafminer have recently penetrated the northern Jarrah forest and there is an urgent need to slow down this expansion northwards. Outbreaks of Gumleaf Skeletonizer began in the southern Jarrah forest in 1983 and the deteriorating condition of this forest is causing considerable concern to forest managers. In certain pine plantations, the introduced bark beetle *Ips* is heavily infesting trees and so a program of biological control has to be intensified. Infestations of millions of hectares of Flat-topped Yate woodland over the lower Great Southern Region by a Lerp are causing concern about the long term future of both remnants on private land and larger populations in National Parks. Finally, the continued outbreak of *Sirex* wasp in South Australia increases the chance that this species will eventually gain entry to Western Australia; CALM will ensure that it will be detected as early as possible and controlled before it can damage the pine resource.

By 1994 there should be a considerable increase in knowledge about the ecology of these pest insects and their impacts on their host trees. We hope then

to be able to indicate to land managers how stands currently free of pest insects can be kept so, and how stands currently infested can be treated so as to reduce infestation to an acceptable level.

## ACHIEVEMENTS

An operational-scale experiment examining if a single Autumn fire can reduce Jarrah Leafminer infestation was set up in Collie District. This consisted of a 240 ha plot, half of which was burnt in Spring 1988 and the rest burnt in Autumn 1989. Leafminer abundance was sampled before burning, as was the condition of the crowns of 180 sample Jarrah trees.

The hypothesis being tested is that, because Autumn fires scorch tree crowns, the flush of new, small leaves would be unsuitable oviposition sites. The Jarrah in the stand should then have one full year in which to redevelop crowns and increase starch reserves. If successful, the research could lead to modification of current fire protection practices in Jarrah forest.

Three species of parasitoid of Gumleaf Skeletonizer have been collected. One of these was common in the southern Jarrah Forest. Another occurred infrequently, although in South Australia it is common.

Two biological forms of Gumleaf Skeletonizer have now been found in Western Australia. One form, with one generation per year, occurs in Jarrah forest whereas a form with two generations per year occurs in the lower southern Wheatbelt and south coast near Walpole.

Identification of the Lerp infesting Flat-topped Yate has been verified as *Cardiaspina brunnea*. Prior to 1982 this species was known only from NSW.

Construction of a modern, functional insectary complex at the Manjimup Research centre has been approved.

## AIM

To develop methods for controlling economically important insect populations and to investigate the impact of these insects on mortality, health, growth

and reproduction of plants (excluding agricultural plants).

## PRIMARY OBJECTIVES

### Ecological Knowledge

To understand the relevant ecological characteristics of pest insect populations on trees. To investigate the impact of pest insects on the mortality, health, growth and reproduction of trees.

### Stand Management

To elucidate how stands can be managed (which may include logging, thinning, regenerating, burning) in the presence of insect pests. To determine how stands differ in their resistance to insect pests and to develop a stand hazard-rating system.

### Control

To develop cost-effective and scientifically-sound methods of controlling populations of pest insects on trees and in wood products.

### Communication

To communicate research results in the form of technical and scientific publications, educational literature, committee representation, and to provide advice and liaison with other CALM staff, other Departments, and the community at large by way of training courses and seminars.

## 20 YEAR GOALS (based on current resources and in priority order)

1. Minimize the economic and conservation impact of pest insects in Jarrah, Karri and pine forest and Flat-topped Yate woodland using appropriate methods.\*\*\*
2. Complete a checklist of potential pest insect species in the forests of south-western Australia, together with details of their distribution.\*\*
3. Monitor on a broad-scale insect infestation of trees in other ecosystems in Western Australia.\*
4. Expand research in conservation entomology.\*

## 5 YEAR GOALS

1. Determine the impact of Jarrah leafminer (JLM) on foliage, crown condition, wood growth and mortality of Jarrah, and investigate the cause of, and monitor the extent of, the outbreak.
2. Determine the impact of Gumleaf Skeletonizer (GLS) on foliage, crown condition, wood growth and mortality of Jarrah, investigate the cause of and monitor the extent of the outbreak, and clarify the annual cycle of GLS and its predators and parasitoids.
3. Determine the impact of Lerp on foliage, crown condition and mortality of Flat-topped Yate, and investigate the cause of, and monitor the extent of, the outbreak.
4. Maintain liaison with advances in research into insect pests of pine in the Eastern States (mainly Ips and Sirex).
5. Investigate the impact on regrowth Karri and the causes of infestation by the borer *Tryphocaria acanthocera*.
6. Determine the composition, distribution and economic impact of the termite fauna of metropolitan Perth.
7. Curate, maintain and protect the principal State collection of forest insects.
8. Elucidate how Jarrah stands can be managed in the presence of JLM and GLS infestations.
9. Search for Flat-topped Yate trees or stands resistant to Lerp infestation.
10. Evaluate the suitability of parasitoids for biological control of JLM, GLS and Lerp.
11. Prepare detailed prescriptions for the release of parasitoids and predators of Ips in pine plantations throughout the South West.
12. Prepare detailed prescriptions for monitoring of selected pine plantations to ensure the earliest possible detection of Sirex; also detail the action required should Sirex establish in Western Australia.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)**

1,2(part),6,7,12,13,14,15,16,23,24,27,28,30,31,33,36,37

**PROPOSED NEW PROJECTS - with existing resources (in priority order)**

Jarrah Leafminer: 28 (part); Gumleaf Skeletonizer: 10,31; Lerp: 16,18,19,20,32,34,35

**PROPOSED NEW PROJECTS - with additional resources (in priority order)**

Jarrah Leafminer: 5,26; Gumleaf Skeletonizer: 11,29

Together with:

- Develop appropriate methods of insect pest management for Jarrah forest set aside for conservation.
- Investigate the impact of repetitive defoliation by insects on nutrient levels in, and physiological condition of, the Jarrah pole (jointly with Silviculture and Plant Diseases Programs).
- Assess whether outbreak densities of defoliating insects reduce the abundance of other invertebrate species, and hence of bird populations (jointly with Fauna Conservation Program).
- Assess whether application of fertilizer to Jarrah ameliorates or aggravates damage caused by JLM and GLS (jointly with Silviculture Program).

- Determine whether resistance of Jarrah to JLM or GLS infestation is genetically based (jointly with Silviculture Program).

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Abbott, I. (1988). More boring insects. *Landscape* 4: 42-46.

\*Abbott, I. (1989). Out on a limb. *Landscape* 4: 18-21.

\*Abbott I. (1989). Review of "Forest bird communities of the Hawaiian Islands : Their dynamics, ecology, and conservation" by J.M. Scott, S. Mountspring, F.L. Ramsay and C.B. Kepler, 1986. *Emu* 89: 64.

\*Abbott, I. and Van Heurck, P. (1988). Widespread regeneration failure of *Persoonia elliptica* (Proteaceae) in the northern Jarrah forest of Western Australia. *J.R. Soc. W.Aust.* 71: 15-22.

\*Abbott, I., Dell, B. and Loneragan, I.D. (1989). The Jarrah plant. In "The Jarrah Forest: a complex Mediterranean Ecosystem" (ed. B. Dell, J.J. Havel and N. Malajczuk), pp. 41-51. Kluwer, Dordrecht.

\*Abbott, L.K. and Abbott, I.J. (1989). Effects of agricultural practices on the soil biological environment for plant growth. *Tech. Rep. Div. Res. Mgt., Dept. Agr. No. 95: pp. 91-103.*

\*Majer, J.D. and Abbott, I. (1989). Invertebrates of the jarrah forest. In "The Jarrah Forest: a complex Mediterranean Ecosystem" (ed. B. Dell, J.J. Havel and N. Malajczuk), pp. 111-112. Kluwer, Dordrecht.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90	
Ecological Knowledge	Jarrah Leafminer (JLM)	1	Impact on wood growth (I Abbott)		
			45/87	No action	Await growth data from Inventory Branch
			24/86	Plot remeasured Dec 88	Remeasure wood growth Dec 89
			27/84	Analysis completed	Write up
		2.	Annual monitoring of defoliation (I Abbott)		
			44/87	Damage to tagged leaves measured Sep 88. New cohort tagged.	Measure damage to tagged leaves Sept 89
			20/84	New leaves tagged in 20 plots in Manjimup District Nov 88	Measure damage to tagged leaves Nov 89 & tag new cohort
			20/84	Leaves tagged Nov 84 in Manjimup District measured quarterly for damage up to Feb 88.	Analyse & write up
			20/84	Leaves tagged Nov 85 in Manjimup District measured quarterly for damage up to Feb 88	Analyse & write up
			2/85	Damage to tagged leaves in NJF measured Nov 88	Analyse
			-	Aerial survey of forest in Collie District Oct 88 In press	Repeat Oct 89 -
		3	Crown decline (I Abbott) 45/87		
			20/88	Crowns of selected trees rated & photographed, Collie District 180 trees marked, Proprietary block, Collie District	Monitor Monitor
		4	Tree mortality (I Abbott) 20/88		
		5	Cause of outbreak (I Abbott)	No action	-
	Gumleaf Skeletonizer (GLS)				
6	Annual cycle of GLS, predators and parasitoids (I Abbott) 23/85	Data sorted and analysed Annual sampling of 45 trees Jan 89 for GLS only	Do annual sampling of 45 trees Jan 90		
7	Distribution of GLS N of outbreak zone (I Abbott) 48/87	Surveyed Kirup & Collie Districts Sept 88	Write up & continue monitoring Sept 89		
8	Annual monitoring of outbreak (J Farr)	Done Jan 89. (Due to population decline no aerial damage visible).	Repeat Jan 90 (Spotter aircraft). Continue liaison with CSIRO remote sensing unit		
9	Crown decline (J Farr, I Abbott) 61/86	Crowns of 45 trees rated & photographed Jan 89	Repeat crown assessment Jan 90		
10	Tree mortality (J Farr)	-	New project : Prepare RPP		
11	Cause of outbreak (J Farr)	-	New project : Prepare RPP		

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
		12 <i>Uraba</i> taxonomy (J Farr)	WA specimens sent to Waite Institute. Comparison with SA specimens inconclusive	Further liaison with Waite institute; Begin breeding experiments when new insectary operational
		14 Spatial distribution of pupae (J Farr) 39/88	RPP prepared. Experiment deferred because of very low densities of late instar larvae	Ongoing
		15 Fecundity in relation to pupal mass (J Farr) 41/88	RPP prepared. Experiment deferred for same reason	Ongoing
	Lerp	16 Life cycle studies (J Farr)	Monitored tagged leaves over 6 months	Prepare RPP & continue monitoring
		17 Taxonomy (J Farr)	Adults sent to K Taylor CSIRO Canberra. Species identification verified	-
		18 Crown decline (J Farr)	Study sites selected	Prepare RPP
		19 Tree mortality (J Farr)	Study sites selected	Prepare RPP
		20 Population monitoring (J Farr)	Pilot study of trapping methods completed	Prepare RPP
	Pests of pine	21 Ips, Sirex (J Farr, I Abbott)	Expert advice provided to other Divisions of CALM	As required
	Other insects (potential pests) in jarrah forest	22 Assemble basic life history details, distribution (I Abbott, J Farr)	Data collected opportunistically	Opportunistic
	<i>Tryphocaria</i> borer in karri	23 Distribution & intensity of infestation (I Abbott) 32/85, 59/86	G Inion's plot data incorporated into analysis. Data analysis completed	Write up
	Termite occurrence in Perth Metro area	24 Species present and location of 'hot spots' in Metro area; Damage impact (I Abbott)	Survey by Pest Control companies completed Dec 88	Hire consultant to sort & analyse samples (funded by WURC)
	Curation, maintenance & protection of pinned & spirit-collection of insects, collection of wood samples showing insect damage, and herbarium of insect-damaged foliage	25 Provide identification service of insects damaging wood or foliage, and maintain records of occurrence of infestations (I Abbott, J Farr)	Better housing obtained for collection. Computerized data base for spirit collection completed	Incorporated SJF samples into spirit collection. Complete computerized data base for pinned collection
Stand Management	JLM	26 Stand hazard rating (I Abbott)	Pilot project initiated with CSIRO Remote Sensing Unit with contingency funds provided by General Manager	Await report
		27 Frequency of occurrence of resistant trees in NJF (I Abbott) 45/87	Analysed	Write up
		28 Effects of fire & thinning (I Abbott) 20/88	Transect lines marked, JLM cut outs collected in cone traps Oct. 88. Autumn fire April 89.	Ongoing

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
		29 Stand hazard rating (J Farr)	Pilot project initiated with CSIRO remote sensing unit with contingency funds provided by General Manager.	Await report
		30 Effect of fire on GLS, predator & parasitoid abundance (J Farr) 19/87	Sampled Jan 89. Fire deferred because of low caterpillar densities	Resample Jan 90. Reschedule Autumn fire for Autumn 90 if GLS population increases
		31 Effect of thinning (J Farr)	-	New project : Prepare RPP
	Lerp	32 Resistant trees (J Farr)	Study sites selected	Prepare RPP
Control	JLM	33 Impact of parasitoids (I Abbott) 47/87	All blocks between Jarrahdale & Collie surveyed	Extend survey N to Julimar & parts of Swan coastal plain
	GLS	34 Biocontrol (J Farr)	3 spp parasitoids found	Continue sampling. Prepare RPP once new insectary is operating
	Lerp	35 Biocontrol (J Farr)	1 sp parasitoid found	Continue sampling. Prepare RPP once new insectary is operating
	Ips	36 Prescription for introduction of parasitoids and predators (I Abbott)	Finalized. Introductions from S Aust begun	Continue introductions
	Sirex	37 Prescription for monitoring for presence Sirex and procedures to be followed if an outbreak occurred (I Abbott)	Finalized. Monitoring begun Oct 88 by Silviculture Branch	Liaise with Operations about ongoing monitoring

# FAUNA CONSERVATION PROGRAM

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## PROGRAM LEADER

JA Friend

## CURRENT RESOURCES (1989/90)

This program comprises 9.30 persons (3.95 Professional + 0.50 Contract Professional + 4.85 Technical). Its estimated CRF budget is \$432 427 (including \$282 977 salaries and \$149 450 operating costs).

## RESOURCES IN PREVIOUS YEAR

Some minor changes in staff through 1988/89 resulted in the loss to this program of 0.75 FTE, thus continuing the trend previously established. Changes in external support for projects have resulted in some losses and other gains, but the nett impact has been negative. Further demands on the program are, however, being made. To be met, these demands will require funding to permit use of consultants. The program in 1988/89 had a CRF budget of \$470 226 (including \$321 211 salaries and \$149 015 operating costs). An additional \$134 680 was attracted from external sources during the period.

## BACKGROUND

The indigenous vertebrate fauna of Western Australia, excluding fish, comprises more than 1000 species: 475 birds; 135 mammals, including nearly 70 marsupials; 360 reptiles; and 70 amphibians. The dingo is the only mammal species 'not protected'. In addition, 16 species of venomous land snakes and all seasnakes are 'not protected'. Conversely, 43 mammals, including 27 marsupials (40%), 11 other land mammals (15%) and 5 marine mammals, 40 birds (8%), 19 land dwelling reptiles (5%) and one marine turtle, and one frog species had been declared as threatened fauna.

Among the extensive invertebrate fauna, only beetles of the Family Buprestidae and ants of the Genus *Nothomyrmecia* are presently included in the category of 'protected fauna'.

Of the recognized fauna, most species occupy land other than that dedicated for conservation (CALM controlled land). Few even of the threatened species are confined solely to CALM land. Departmental responsibility for conservation of the State's fauna

thus implies a responsibility for conservation of species at large throughout the State for the most part. Fauna conservation research therefore spans the whole range, from management of abundant species such as the larger kangaroos on rangelands to protection and restoration of populations of endangered species such as the Noisy Scrub-bird. Requirements for fauna conservation research data are thus correspondingly broad.

Discovery of populations of some threatened species still depends on opportunistic observation, such as for the Dibbler in 1985, and Shortridge's mouse more recently in the Fitzgerald River National Park, and requires co-ordination of information that may come from a wide range of sources. The ability to respond to such chance events is most important.

Threatened species have perhaps received the greatest attention, but not all are amenable to an intensive formal research project internalized within CALM. Species-orientated projects may also not necessarily result in readily obtained improvements in conservation status.

Translation of research knowledge into practical operational management is another particular problem. Because of these factors, the approach adopted for conservation of threatened species is flexible. The problems likely to be posed however are not usually amenable to quick resolution and so need continuing resource commitments within CALM.

The rarer species are not the sole faunal group requiring attention. There is no infallible method for predicting which of today's currently abundant species might be tomorrow's 'threatened fauna'.

Research into adverse impacts of feral exotic species on the indigenous fauna has so far focussed on predators. The impact of predation on relict mammal populations has been demonstrated and remains a threat to conservation of the species affected. The more indirect impacts that may result from habitat modifications by grazers, interference effects and direct competition for resources have not yet been addressed.

Research aimed at management of conservation areas in ways benefiting particular species has generally been the focus of 'threatened fauna'



species work in the past. Wider studies relevant to this aspect of fauna conservation overlap various other programs, particularly fire and flora conservation. The requirement for CALM to manage land for economic resource production (e.g. water and timber production, mining) also demands broadly-based research knowledge and integrated applications development where the multiple use objectives are to be satisfied in practice.

Studies on communities of fauna and the processes affecting them are thus an integral part of the fauna conservation research program.

Research on the marine fauna has to date been narrowly focussed and will remain so in the near future. Dugongs, marine turtles, seals and sealions, seabirds, and some data base applications in regard to the above and some cetaceans will continue to be dealt with under this program. Other aspects will be subject to development of the more specialized marine conservation research program.

Current resources of the fauna conservation research program do not permit any real attempt to research the invertebrate fauna.

## ACHIEVEMENTS

Co-operative research on captive breeding of the Western Swamp Tortoise in 1988/89 resulted in the production of 11 hatchlings. It is hoped that these hatchlings can be reared to maturity and thus add substantially to the known numbers of this critically endangered reptile.

Continuing studies of the marine turtles have now shown that adult female green turtles dispersing from west Kimberley rookeries can travel as far as Northern Territory and Queensland waters. An Exmouth Gulf nesting loggerhead (one of only 21 females tagged) was also reported from the Northern Territory. A loggerhead turtle nesting at Varanus Island in the Lowendal Islands Nature Reserve in the 1988/89 season was the fourth nesting species to be recorded from this site. Continued involvement of West Kimberley Aboriginal people in the project work was sustained and at North West Cape - Ningaloo and in the Pilbara, other members of the public were successfully involved.

Better reporting of the occurrence of leatherback turtles in Western Australian west coastal areas has pointed to a possible problem of significance to conservation of this most endangered marine turtle.

The majority of reports have resulted from fatal but accidental entrapment in commercial fishing gear.

Some important flatback turtle rookery sites have been identified off the Kimberley coast.

Funding from World Wildlife Fund Australia permitted expansion of research on the Ground Parrot. It was discovered that breeding commenced at least two months earlier than previously believed, and that these birds were inhabiting long unburnt plant species-rich heaths, and were also at much lower densities than in eastern Australia.

Surveys in February 1989 at Boyagin Nature Reserve showed that the Numbat re-introduction project conducted through 1985-87 was having continued success. Numbats were found through most of the eastern half of the reserve.

Numbats were also bred in captivity again, the only success since 1985, when it was first achieved. Provision of improved diet and quiet surroundings apparently contributed to this favourable result.

Wheatbelt rock-wallaby populations remained high, continuing to demonstrate the value of fox control in protecting remnant mammal populations.

Further information on distribution of the Chuditch was obtained and a reporting network at Operations level initiated.

## AIM

To provide scientific information to ensure effective conservation and management of Western Australia's marine and terrestrial fauna.

## PRIMARY OBJECTIVES

### Knowledge

To increase knowledge of the fauna and the ecosystems in which they occur.

### Community Studies

To conduct and/or promote research that will lead to better understanding of the structure and function of ecosystems and the fauna therein.

### Population Studies

To identify threatened fauna and seek understanding of factors affecting the status of populations, and to prepare wildlife management programs for species that require management. To provide a sound basis for conservation and management of exploited fauna, and to prepare wildlife management programs for exploited species. To research methods and provide management programs for control of feral and other exotic species adversely affecting fauna conservation.

### Management Applications

To provide a scientifically sound practical basis for implementation of fauna management, to assess the impact(s) of management and for recommending necessary modifications.

### Public Involvement

To promote understanding and appreciation of fauna conservation by actively encouraging the involvement of the public in appropriate research projects and in the process of development and implementation of management applications.

### Communication

To communicate effectively results of research by way of public contact, production of specialist publications, input into the management planning process, and the provision of management prescriptions as required so that transfer of research knowledge to the management area is facilitated and public appreciation of nature conservation is increased.

### **20 YEAR GOALS (based on current resources and in priority order).**

1. Extend and expand research which promotes understanding of the structure and function of ecosystems and their fauna.\*\*\*
2. Extend and expand research which promotes understanding of the biology and ecology of species and groups of fauna for which Western Australian populations are of major conservation significance.\*\*\*
3. Develop and maintain a system that encourages and actively stimulates wider public involvement in fauna conservation research.\*\*\*

4. Extend and continue conservation programs for threatened fauna.\*\*
5. Extend and expand research necessary to achieve effective economic and practical management of adverse impacts of feral exotic fauna on conservation of the native fauna.\*\*
6. Maintain and develop as necessary programs for monitoring the impact of land management activities on fauna so as to guide and redirect as required management practice(s) towards effective conservation.\*\*
7. Develop conservation research on the terrestrial invertebrate fauna.\*

### **5 YEAR GOALS**

1. Identify any additional relict populations of current threatened (rare and endangered) fauna species.
2. Develop and maintain appropriate data bases and conduct studies to integrate specialized knowledge of fauna.
3. Conduct research on faunal communities which include feral exotic fauna in cases where the nature of anticipated impacts is uncertain, but the need for more intensive future management is foreseen.
4. Develop effective economic and practical control programs for selected feral exotic fauna for implementation in cases where adverse effects on conservation of native fauna are demonstrable or clearly indicated and special management is required.
5. Conduct research and develop effective economic and practical management programs for threatened fauna requiring management support. Management may include population enhancement involving translocation and reestablishment, captive breeding programs, predator control and special habitat manipulation.
6. Increase understanding of the biology and ecology of species and groups of fauna for which Western Australian populations are of major conservation significance, and especially where such knowledge can be applied to specific management and planning needs and facilitate

the process of public involvement in conservation work.

7. Develop and evaluate field study techniques applicable to fauna research studies and monitoring of management applications.
8. Develop an appropriate network of contacts and secure resources so as to increase the level of public involvement in fauna conservation field research and management applications.
9. Assist in the development of fauna management programs in cases where traditional Aboriginal exploitation is a significant factor.
10. Provide support as required to administrative and policy areas of CALM in regard to maintenance of continuity in operation of exploited species management programs, e.g. kangaroos, quota advice.
11. Establish working communications with Regions and District Offices so that the program can more effectively assist in meeting needs for specialized knowledge on fauna conservation topics and in planning to meet needs for further research.

#### PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994

1-19, 21-25, 27-28

#### PROPOSED NEW PROJECTS - with additional resources (in priority order)

Nil.

#### PROPOSED NEW PROJECTS - with existing resources

Nil.

#### PUBLICATIONS \* AND REPORTS 1988/89

\*Burbidge, A. and Friend, J. (1988). Back from the edge of extinction. In Newman, P., Neville, S. and Duxbury, L. (eds). *Case Studies in Environmental Hope*. pp. 29-35. EPA, Perth.

Burbidge, A.H., Watkins, D. and McNee, S. (1989). Conservation of the Ground Parrot in Western Australia. Unpubl. Final report to World Wildlife Fund (Australia).

\*Friend, J. (1988). Saving the Numbat. *Wildlife Australia*, 25: 18-20.

\*Griffiths, M., Friend, J.A., Whitford, D. and Fogerty, A.C. (1988). Composition of the milk of the numbat *Myrmecobius fasciatus* (Marsupiala: Myrmecobiidae) with particular reference to the fatty acids of the lipids. *Aust. Mammal*, 11: 59-62.

\*Kinnear J.E. (1989). Outfoxing the fox. *Landscape*, 4:

Kinnear, J.E. and Algar, D. (1989). ANPWS Fox Project. Unpubl. final report, Phase II.

\*Kinnear, J.E., Bromilow, R.N., Onus, M.L. and Sokolowski, R.E.S. (1988). The Bromilow Trap: A new risk-free soft trap suitable for small to medium-sized Macropodids. *Aust. Wild. Res.* 15: 235-237.

\*Kinnear, J.E., Onus, M.L. and Bromilow, R.N. (1988). Fox control and rock wallaby population dynamics. *Aust. Wildl. Res.*, 15: 435-450.

\*Prince, R.I.T. (1988). Traditional knowledge of the marine environment, fisheries, and conservation of marine wildlife - a Western Australian perspective. In F. Gray and L. Zann (eds). *Traditional knowledge of the marine environment in Northern Australia*. Proceedings of a Workshop ... Townsville, Australia, 29-30 July 1985. pp. 116-9. Workshop series No. 8 (GBRMPA, Townsville).

Prince, R.I.T. (ed.) (1989). Western Australia. Turtle Research Newsl. No. 1, March 1989. 5pp + 1 Fig. (Wildlife Research Centre, CALM, Wanneroo).

Prince, R.I.T. (1989). Dugongs: Conservation and Management. Poster presentation. Marine Mammal Session. Australian Veterinary Association National Conference, Perth. 27 March - 1 April, 1989.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
Knowledge	Specialized knowledge	1 <u>Mormopterus</u> taxonomy (RS130) NL McKenzie	No progress	Complete work as opportunity arises
		2 Australian landhoppers (RS44) JA Friend	No further progress	Identify collection from E. Gippsland. Plot S-W distribution data for paper
		3 Decline of W.A. mammals (RS8)	Paper in press	
		4 Formation of karri tree hollows	Preliminary survey data gathered; in suspense due to staff loss	Continue if/when resources available
Knowledge; Community Studies	Feral exotic; control programs	5 Forest fauna habitats RIT Prince		Preliminary investigation of resource base and dependent fauna
		6 Fox biology and fox control (RS104, 105-111) D Algar	Estimated density, home range and social structure of foxes in Watheroo NP. Calibration of density indices. Preliminary study of fox status in Gibson Desert Nature Reserve	Conduct density trials Kalbarri NP. Examine fox dispersal for bait frequency modelling. Follow-up assessment of baiting trials at Watheroo NP. Establish baiting program for Gibson Desert Nature Reserve
	Biology, ecology	7 Fox Ecology JE Kinnear	Small mammal trapping, FRNP. 1080 tolerance testing of select sps from FRNP. Biodegradation of 1080 in baits and soils; exploratory studies completed. Exploratory bait longevity trials Tutanning Nature Reserve	Prebaiting mammal census FRNP: Partial fox baiting of FRNP. Bait longevity and potency trials wheatbelt. Biodegradation of 1080 - further studies. Rock-wallaby census, all wheatbelt populations. Tamar, woylie census, Tutanning Nature Reserve
Knowledge; Population Studies	Identify relict populations; specialized knowledge; potential impacts of feral exotic; management support; biology and ecology	8 Rock Wallaby conservation (RS103, 104-105) JE Kinnear	Kalbarri, Wheatbelt, Cape Range NP RW population monitored, Edgar Range populations survey	Continue monitoring Kimberley RW; Nookanbah pop survey. L. Argyle RW Survey.
		9 Rock Wallabies, Dampier Archipelago (RS108) JE Kinnear	Paper in preparation	Submit for publication
	Management support; biology and ecology	10 Rock Wallabies, East Pilbara (RS108-109) JE Kinnear	Paper in preparation	Submit for publication
		11 Numbat study. Habitat and food sources (RS39-41) JA Friend	Identification of termites for feeding activity study	Complete papers on feeding activity and termites. Complete draft management plan for the numbat
	Identify relict populations; management support; biology, ecology	12 Chuditch conservation (RS147-149) KD Morris	Developed management protocols, conducted surveys to establish presence/absence of Chuditch in suitable habitat. Liaison with operations	Continue
		13 Western Barred-bandicoot (RS43-44) JA Friend	Spotlight surveys and home range measurement, August 1988	Field trip in September 1988 to investigate use of different vegetation types at White Beach, Dorre Island

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
	Management support; biology, ecology	14 Ground parrot conservation (RS17-18) AH Burbidge	WWF project on habitat use	Continue FRNP work; prepare publications
	Management support; biology, ecology	15 Mammals of Pilbara Islands KD Morris	Proposals refined for <u>Leggadina lakedownensis</u> work on Thevenard Island	Proceed with Thevenard Island work re <u>Leggadina lakedownensis</u> conservation & House Mouse invasion.
	Identify relict populations; develop management support programs	16 <u>Pseudomys praeconis</u> surveys KD Morris	WWF funds secured. Consultancy let to search for relict populations; develop management support program	Proceed with work
		17 Hooded Plover conservation AH Burbidge	Funding application prepared & submitted to ANPWS	Proceed in association with RAOU if funding provided
	Identify relict populations; specialized knowledge; biology, ecology; public involvement	18 Western desert mammals (7/86) D Pearson	Surveys for rare mammals in Gibson Desert Central Ranges	Complete Central Ranges survey and prepare report for ANPWS
	Management Support	19 Western Swamp-Tortoise breeding (RS9-10) AA Burbidge	Funds secured via WWF, consultancy work in progress; hatchlings produced	Continue
	Management support; techniques	20 Western Swamp-Tortoise populations (RS9-10) AA Burbidge	Seasonal work completed as required	Continue
	Management support, biology, ecology	21 Numbat study - translocation and reestablishment (RS43-43) JA Friend	Translocation to Karroun Hill carried out with WWF and Australian Geographic support (monitoring by radio-tracking continued). Diggings survey of Boyagin carried out. WWF report in preparation	Translocation to Karroun Hill. Monitor diggings at Boyagin and devise regular survey regime. Complete Boyagin report for WWF and draft management plan
	Management support, biology, ecology	22 Banded Hare-Wallaby, Stage 3 (RS141) RIT Prince	Project suspended due to land tenure problems at Shark Bay & insufficient funds	Reactivate when problems solved with implementation of Shark Bay Region Plan
	Management support; techniques	23 Woylie Populations (2/83)	Major monitoring in suspense	Monitor Perup release area
	Management support; techniques	24 Woylies in NR's etc. (RS102) JE Kinnear	Trapping work, monitoring of occurrence at Dryandra, Tutanning & Boyagin NR's, Fitzgerald River NP	Continue
Population Studies; Management Applications	Potential impacts of feral exotic; control programs; techniques; contact with Regions	25 Exotic fauna, rats on islands (RS134-135) KD Morris & RIT Prince	Work in suspense due to technical problems re target specificity	Prepare paper on work undertaken to date; reassess applications
Management Applications	Field study techniques	26 Pitfall trapping methods (RS16-17) AH Burbidge	No action	Opportunistic
	Specialized knowledge; specific needs; techniques; contact with Regions	27 Seabird database AA Burbidge	Database maintained & updated; paper prepared	Continue; paper(s) integrating knowledge to be prepared

<b>Primary Objectives</b>	<b>5 Year Goals</b>	<b>Projects (RPP No.)</b>	<b>Tasks completed 1988-9</b>	<b>Targets 1989-90</b>
	Specialized knowledge; specific needs; techniques; contact with Regions	28 Island fauna database AA Burbidge	Database maintained & updated; data incorporated into draft paper	Continue; submit paper
	Techniques; administrative support	29 Kangaroo management programs RIT Prince	Harvest quota advice provided. Planning for collaborative analysis of harvest and population data with ANPWS, NKMU personnel commenced	Ongoing

# FIRE PROGRAM

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## PROGRAM LEADER

N Burrows

## CURRENT RESOURCES (1989/90)

This program comprises 16.60 persons (5.95 Professional + 10.25 Technical + 0.40 Contract Technical). Its estimated CRF budget is \$749 862 (\$551 807 salaries and \$198 055 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 15.80 persons (5.35 Professional + 10.45 Technical). Its budget was \$688 989 (\$491 429 salaries and \$197 560 operating costs).

## BACKGROUND

Fire is an important, complex environmental factor affecting land resources administered by CALM. CALM has a legal and moral obligation to protect life and property from destruction by wildfire and to ensure appropriate fire regimes are implemented to protect and enhance production and conservation values.

Almost all land managed by CALM is fire prone. Throughout the State, periods of hot dry weather when combined with flammable vegetation provide the potential for large and costly wildfires to develop. Research into fire behaviour and fuel modification within the major vegetation types will provide managers with techniques for minimizing the impact and severity of wildfires. In the past, most fire behaviour research effort has been centred on the populated, commercial forest regions of the south west and has contributed considerably to the current high level of fire management expertise. Fire behaviour research is now extending to the heathlands, mallee shrublands and hummock grasslands where there is historical evidence of large and destructive wildfires in Parks and Reserves managed by CALM.

The ecological importance of fire to conservation of the native biota is well acknowledged. A firm understanding of fire effects and of the role of fire in maintaining natural processes is essential for determining appropriate fire regimes and for predicting temporal and spatial effects. The use of

fire as a management tool is an important ecological issue which can be resolved in part by scientific research. Fire ecology research is complex and requires long term commitment of resources to ensure a sound basis for applied fire regimes. Fire ecology research will continue in forests, woodlands, heathlands and hummock grasslands. To ensure the most effective use of research resources, complementary fire behaviour - fire effects studies will be conducted in these major vegetation types and on a systematic basis. By 1993, there should be a considerable increase in knowledge of fire behaviour, fire effects and therefore fire management in major forest types, heathlands, mallee shrublands, woodlands and hummock grasslands.

## ACHIEVEMENTS

The proceedings of the National Workshop on Fire Management on Nature Conservation Lands, hosted by CALM in October 1987, was published as a Departmental Occasional Paper (1/89) in May 1989. Copies have been distributed to all Workshop delegates, and to many individuals and organizations concerned with fire management and conservation in Australia. The document makes a valuable contribution to knowledge of this subject.

In the arid zone, a study of early black and white aerial photography was initiated to gather information on Aboriginal burning practices in desert areas. In association with this work, patch burning, using incendiaries dropped from aircraft, was successfully implemented in the Gibson Desert Nature Reserve. Data on fire behaviour, and the response of mammal, bird and reptile populations to these burning patterns are also being gathered in this reserve. Similar work on the effect of fire on small desert vertebrates is also being undertaken at Queen Victoria Springs Nature Reserve. In the Goldfields a plan for fire research and management of desert reserves was prepared in conjunction with Regional staff.

In the south-west of the State a successful experimental burn was carried out in Durokoppin Nature Reserve (near Kellerberrin) in mid March 1989; work on invertebrates in the burnt area and on adjacent unburnt plots is continuing. Near the south coast, integrated studies on fire behaviour and the effects of fire on vegetation and small vertebrates have commenced in mallee-heath shrublands in the

Stirling Range National Park. Work on invertebrates (particularly spiders, beetles and termites) in relation to fire is also underway in the Park, through a consultancy using funds provided by the World Wildlife Fund. Guidelines for eradicating wildings from *Pinus radiata* plantations were provided for use by Operations staff; and a summary of information concerning the fire ecology of rare plants occurring in south-west forests also was prepared.

## AIM

To develop fire behaviour models, appropriate fire regimes and to predict the effects of various fire regimes on production, protection and conservation values.

## PRIMARY OBJECTIVES

### Fire Behaviour And Suppression

To develop fuel characteristic and fire behaviour prediction models for major vegetation types throughout the State. To assist with the development of operational guidelines for wildfire pre-suppression and suppression and to evaluate their effectiveness and impact on the environment.

### Fire Ecology

To determine the short and long-term effects of various fire regimes on plant and animal communities, especially on sensitive or rare flora and fauna, and to prepare relevant fire management guidelines. To identify critical plant and animal species and communities which may be readily monitored and used as biological indicators of the relationship between fire and the environment.

### Fire Management

To develop management systems which integrate fire behaviour, suppression, fire effects and relevant resource information for a range of biomes (habitat types in similar climatic zones). To provide advice on appropriate fire regimes and prescriptions for inclusion in management plans.

### Communication

To communicate research results in the form of technical and scientific publications and educational literature, by liaison with other CALM staff, other

Departments and the public, and by assisting with training courses.

## 20 YEAR GOALS (based on current resources and in priority order).

The favoured long term strategy is to direct Fire Program resources to deal successively with each major vegetation type, i.e. to conduct simultaneous and complementary research into all aspects of fire in one type, culminating in an integrated management system. This will not always be practical, but it is clear that there will never be sufficient resources to conduct many types of research in all vegetation types simultaneously. The 20 year goals will complete the development of management systems which integrate fire behaviour, suppression, fire effects, monitoring systems and relevant resource information for the following major vegetation types in order of priority:

1. Native and exotic forests of the south-west. \*\*\*
2. Heathlands and mallee shrublands. \*\*\*
3. Semi-arid woodlands and hummock grasslands. \*\*
4. Banksia woodlands, mulga woodlands and tropical savanna woodlands. \*

This will involve a wide range of research projects within each major vegetation type in order to obtain information and understand processes. It will not be practical to concentrate solely on one type, to the exclusion of others but attempts will be made to integrate and co-ordinate research within a limited number of types as far as possible. The diversity of research undertaken within the fire program also creates difficulties in attempting to rank all projects which are clearly not comparable. Therefore, the following organization of 5 year goals is not seen as rigid.

## 5 YEAR GOALS (with existing resources)

### a. Fire Behaviour and Suppression

1. Develop prescriptions and techniques for safely prescribing fuel reduction burns in young even-aged karri regeneration.
2. Develop a fire model for predicting fuel dynamics and fire spread in heathlands and mallee shrublands and examine the application of



fuel modification techniques such as chaining and burning.

3. Develop fire behaviour and fuel models for hummock grasslands and appropriate techniques for prescribing patch burns in desert reserves and national parks.
4. Complete analysis of fire behaviour studies in jarrah forests and refine existing models.
5. Complete fire protection studies in pine plantations.
6. Prepare fuel accumulation models for Banksia low woodlands and commence fire behaviour studies.

#### **b. Fire Ecology**

1. Study the effects of various fire regimes on forest understorey plant species and some animals.
2. Study the effects of fire on small mammals, herpetofauna and selected invertebrates in semi-arid land (wheatbelt) reserves.
3. Study the effects of fire on heathlands and shrubland flora and fauna.
4. Study the effects of fire on vegetation, mammals and reptiles in hummock grasslands (desert reserves).
5. Study the effects of fire on selected rare and fire sensitive flora.
6. Study the effects of fire on Banksia woodlands.
7. Study the effects of fire on mulga dominated communities especially in Hamersley Range National Park.

#### **c. Fire Management**

1. Develop an integrated, computerized fire management system for Tutanning Nature Reserve (and others).
2. Develop an integrated computerized fire management system for south-west forests,
3. Document traditional aboriginal knowledge on fire aspects (in hummock grasslands) and

develop it into an integrated system for management of desert reserves.

4. Develop management strategies to protect fire vulnerable communities in the Hamersley Range National Park.

#### **d. Communication**

1. Continue to hold formal and informal workshops, meetings and seminars for researchers, managers and community groups.
2. Continue to publish findings and to produce management guidelines.
3. Continue input into land management plans.

#### **PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)**

1,2,3(part),5,6,7,8,9,10,11,13,14,15,17,18,22,24,25, 26,27,28,32

#### **PROPOSED NEW PROJECTS (with additional resources)**

1. Fire regime effects on nutrient regimes in forests.
2. Fire regime effects on understorey species - woodlands.
3. Fire regime effects on northern sandplains vegetation.
4. Fire regime effects on south coast heathlands vegetation.
5. Fire regime effects on mammals - heathlands.
6. An integrated, computerized fire management system for forests.
7. The impact of climate change on the fire environment.
8. The effect of fire on climate change.

#### **PUBLICATIONS \* & REPORTS 1988/89**

\*Bell, D.T., McCaw, W.L. and Burrows, N.D. (1988). Influence of fire on jarrah forest

- vegetation. Chap. 13. In: The Jarrah Forest: A complex Mediterranean Ecosystem (ed. B. Dell, N. Malajczuk and J. Havel). Kluwer, Dordrecht.
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- \*Burrows, N.D., Woods, Y.C., Ward, B.G. and Robinson, A.D. (1989). Prescribing low intensity fire to kill wildings in *Pinus radiata* plantations in Western Australia. Aust. For. 52: 45-52.
- \*Friend, G.R., Dudzinski, M.L. and Cellier, K.M. (1988). *Rattus colletti* (Rodentia: Muridae) in the Australian wet-dry tropics: seasonal habitat preferences, population dynamics and the effects of buffalo (*Burbalus bubalis*). Aust. J. Ecol. 13: 51-66.
- Friend, G.R. and Mitchell, D.S. (1988). Efficient pitfall trapping designs for sampling small vertebrates. CALM Landnote 1/88.
- \*Friend, G.R., Smith, G.T., Mitchell, D.S. and Dickman, C.R. (1989). Influence of pitfall and drift fence design on capture rates of small vertebrates in semi-arid habitats of Western Australia. Aust. Wildl. Res. 16: 1-10.
- \*McCaw, W.L. (1988). Regeneration of *Acacia* and *Kennedia* from soil stored seed following an autumn fire in jarrah (*Eucalyptus marginata*) forest. J. R. Soc. W.Aust. 71:1-6.
- \*McCaw, W.L. and Burrows, N.D. (1988). Fire Management. Chapter 7 In The Jarrah Forest: a complex Mediterranean Ecosystem (ed. B. Dell, N. Malajczuk and J. Havel). Kluwer, Dordrecht.
- \*McCaw, W.L., Smith, R. and Neal, J. (1988). Intense fire behaviour in a 16 year old stand of karri (*Eucalyptus diversicolor*) and yellow stringybark (*Eucalyptus muellerana*). CALM Landnote 3/88.
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Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90	
Fire Behaviour and Suppression	Fuel reduction guides for karri regrowth	1 Karri regrowth fuels 2/84 (L McCaw)	Partially revised	Resubmit for publication	
		2 Prescribed fire behaviour 21/85 (L McCaw)	Field work, some data analysis	Complete data analysis	
		3 Fire damage to karri regrowth 15/85 (L McCaw)	Annual re-measurement of tree growth, crown response and fuel accumulation	Final re-measurement March 1990	
	Fire behaviour in heathlands and mallee shrublands	4 Fire behaviour in heathlands and shrublands 22/88 (L McCaw)	Plots established and protective buffer strips burnt. Commenced fuel assessment	Finalise pre-burn fuel and vegetation work. Conduct 10 experimental fires.	
		Fire behaviour and fuel models - hummock grasslands	5 Spinifex drying trials - 42/87 (N Burrows)	Conduct detailed diurnal studies Sep 1988 & March 1989	Final report
	6 Describing fuel structure and biomass 23/88 (N Burrows)		Prepare paper for publication	Publish findings	
	7 Fire behaviour studies 42/87 (N Burrows)		Conducted further studies Sep 1988 & March 1989	Publish findings	
	8 Historical weather data - Giles 24/88 (N Burrows)		Preliminary descriptive analysis of Giles weather data to ascertain fire seasons & wind patterns	Complete analysis and prepare for publication	
	9 Aero burning techniques 25/88 (N Burrows)		Conducted large scale aero burns in Gibson Desert Nature Reserve for Sep 1988	Publish findings	
	10 Thematic mapping fire patterns 26/88 (N Burrows)		Development of project and costing arrangements with the Remote Sensing Applications Centre. Acquired imagery, commercial ground truthing	Complete ground truthing after aero burn operations in Sep 1988. Map fires	
	Complete analysis and write up of fire behaviour - jarrah forest		11 Field studies - jarrah 28/78 (N Burrows)	Complete data extraction from fire maps	Analyse data
			12 Lab studies of fuels (combustion rates) 18/86 (N Burrows)	Preliminary analysis of data	Complete data analysis
		13 Spot fire development 14/86 (N Burrows)	Preliminary analysis of data	Complete data analysis	
		14 Wildfire threat analysis 27/88 (N Burrows)	Joint project with Protection Branch and Northern Region Mark II Wildfire Threat Analysis completed	Test and refine Mk II version. Introduce to Operations	
	Complete analysis and write-up of fire behaviour studies - jarrah forest	15 A computer system for storing, retrieving and analysing wildfire data 15/86 (N Burrows)	System developed on micros. Some historical data loaded. Draft prepared for publication. Progress reports submitted, Protection staff briefed	Complete loading historical data. Prepare for final publication.	
		16 Fuel studies in southern wetlands 47/86 (N Burrows)	Fourth annual re-measurement of structure and biomass. Progress reports submitted	Re-measure in June 1990. Submit progress reports	
	Prescriptions for prescribed burning in pine plantations	17 Controlling Pine wildings with prescribed fire 16/86 (N Burrows)	Prepared for final publication.	Publish findings	

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90	
		18 Assessing the effectiveness of grazing in fuel reduced buffers 29/88 (N Burrows)	Measured grass biomass production in grazing leases	Prepare final report	
	Fuel and fire behaviour studies in Banksia low woodlands	19 Fuel accumulation rate and structure in Banksia low woodlands 17/86 (N Burrows, L McCaw)	Preliminary investigation complete. Paper submitted for publication	Publish preliminary study. Select sites for further study. Commence assessment	
Fire Ecology	Effects of fire on forest understorey plant species and some animals	20 Effects of 5 fire regimes on forest understorey species 12/86 (N Burrows)	Sites located, plots constructed, pre-burn assessment done. Two sites burnt and post burn assessed. Soil nutrient samples taken	Burn sites in Spring & Autumn 1989. Complete seedling counts, biomass, photography at other sites. Analyse soil nutrients	
		21 Effects of 3 fire regimes on ground-dwelling invertebrates RS36, RS37 (G Friend)	Trap grids in place. Post summer burn trapping continuing. Seasonal sampling of all treatments commenced	Continue seasonal trapping of all treatments	
		22 Regeneration of heartleaf thickets 7/84 (K Maisey)	Annual assessment of post-burn thicket development	Publish findings	
		23 Fire effect on <i>Lambertia rariflora</i> 23/87 (N Burrows)	Sites located, pre-burn assessment completed. Burn postponed due to very dry weather	Burn site in September 1989. Assess postfire mortality & recruitment. Prepare progress report.	
		24 Fire, season and termite activity (with respect to food base for Numbat) 8/84 (K Maisey)	No progress	Complete analysis of data, prepare paper for publication. Prepare management guidelines	
		25 Fire and regeneration of <i>E. wandoo</i> 13/88 (N Burrows)	Assess in Oct 1988. Prepare progress report	Publish findings	
		26 An Age Series of floristics in a single community type in Karri forest RWP 11/88 (G Wardell-Johnson)	Sampling commenced	Complete sampling & prepare for publication	
		Fire effects - semi arid land (wheatbelt) reserves	27 The response of terrestrial vertebrate fauna to disturbance in karri forest RWP 11/89 (G Wardell-Johnson)	Sampling commenced	Complete sampling and prepare for publication
			28 Regeneration strategies of plant species of the Walpole-Normalup National Park RWP 1/89 (G Wardell-Johnson)	Sampling continued	Complete sampling & prepare for publication
			29 The response of bird communities to logging and burning in the karri forest RWP 22/82 (G Wardell-Johnson)	Sampling continued	Continue sampling
30 The formation of hollows in karri and marri trees RWP 46/87 (G Wardell-Johnson)	No Action		No Action		

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90
		31 Does hollow availability limit Mardos in karri RWP 6/84	Annual sampling	Continue annual sampling
		32 Pitfall trapping and sampling techniques RS34 (G Friend)	Paper published	
		33 Effects of prescribed burns on fauna in wheatbelt nature reserves RS34 RS35 (G Friend)	Seasonal trapping and data analysis. Preparation for burning	Continue trapping. Assess habitat & fuels of burn sites this season. Do post burn trapping
		34 Fire effects on vegetation of Tutanning N.R. RS62 RS63 (A Hopkins)	Annual assessment	Do annual assessment & prepare progress report
	Fire effects - heathland and shrublands	35 Fire effects on vegetation - Two Peoples Bay R.R. RS63 (A Hopkins)	Annual assessment. Several draft publications, guidelines for managers - draft management plan	Do annual assessment. Complete publications on 1st 10 years' results
		36 Fire effects on vegetation - Recherche Archipelago RS60 RS61 (A Hopkins)	Annual assessment and progress report	Do annual assessment. Complete publications on work to date
		37 Regeneration after wildfire Mt Lesueur N.R. RS60 (A Hopkins)	Annual assessment of program report	Do annual assessment
		38 Fire effects on vegetation - Stirling Ranges N.P. 30/88 (L McCaw)	Initial assessment of chained/burnt quadrats buffer	Do pre-burn assessment of quadrats over 4 seasons
		39 Fire effects on reptiles, frogs, small mammals & invertebrates Stirling Ranges N.P. 31/88 (G Friend)	As above	As above, plus commence pre-treatment trapping on seasonal basis & describe habitat description
		40 Effects of various fire control strategies on vegetation 15/87 (L McCaw)	Draft paper on Ravensthorpe experiments prepared. Kalbarri quadrats remeasured.	Submit Ravensthorpe paper for publication. Re-measure Kalbarri plots.
	Fire effects - hummock grasslands	41 Effects of mosaic burns on birds 20/88 (AA Burbidge)	Study sites located. Pre-burn census and analysis of variance completed	Do pre-burn census Sep 1988. Burn treatments & do post-burn census
		42 Effects of season of burn and fire size on desert vertebrates 32/88 (D Pearson)	Ongoing trapping. Experimental fires in September 1988 & January 1989. Trap data transferred to disk. <i>Sminthopsis psammophila</i> data written up for publication.	Continue trapping. Preliminary write ups on ecology of individual species. Expand trap grid.
		43 Effects of fire on medium-sized desert mammals 38/88 (D Pearson)	Preliminary trapping and habitual survey of Dalgyte ( <i>Macrotis lagotis</i> )	Continue habitat survey; description of habitat sites.
		44 Effects of fire season & intensity on floral succession 33/88 (D Pearson)	Comparison of techniques to study succession (biomass, plot & plotless methods)	Systematic survey of study area in Queen Victoria Spring N.R.
		45 Effects of patch burning on lizards 34/88 (D Pearson)	Collection and identification of specimens. Pre-fire trapping. RPP prepared	Establishment of trap grids and trapping in Sept, Oct, Dec & Jan.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90
		46 Appraisal of thematic mapping for mapping vegetation 35/88 (D Pearson)	Ground truthing commenced	Complete ground truthing and interpreting. Write up
		47 Fire effects - mulga woodlands (S van Leeuwen)	No action	Prepare RPP's, commence project
Fire Management	Computerized fire management system - Tutanning N.R.	48 RS59 RS62 (A Hopkins)	Extensive collection of field data	Complete data collection and commence model validation
	Computerized fire management system - Forest Regions. (This is largely being co-ordinated by Protection Branch. Judi Beck is preparing computer system for fire behaviour/suppression)	49 36/88 (J Beck)		Employ a systems ecologist to continue with system development
	Document Aboriginal knowledge of fire aspects (hummock grasslands) and develop it into an integrated land system	50 37/88 (D Pearson)	Field work with Ngaanyatjarra men in Central Ranges, mapping land usage & fire patterns	Continue field work, summarize information from other sources. Preliminary write up
		51 Protection of fire vulnerable communities in Hamersley Range National Park (T Start)	No action	Prepare RPP's, commence project.

# FLORA CONSERVATION PROGRAM

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## PROGRAM LEADER

DJ Coates

## CURRENT RESOURCES (1989/90)

This program comprises 5.55 persons (1.30 Professional + 2.50 Contract Professional + 1.75 Technical). Its estimated CRF budget is \$176 715 (including \$113 005 salaries and \$63 710 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 5.70 persons (1.55 Professional + 2 Contract Professional + 2.15 Technical). Its budget was \$194 461 (including \$130 751 salaries and \$63 710 operating costs). \$30 000 was attracted from external sources during 1988/89. This was used to employ the contract staff and provide an operating budget (see Table 3).

## BACKGROUND

Western Australia has a vascular flora world-renowned for its richness (about 10 000 species) and high endemism (75%-80% for the south-west). About 2 000 species have been considered rare, endangered, vulnerable or extinct by various authorities. Some 1 500 species are used commercially in the cut wildflower, seed nursery, bee-keeping and timber industries. While there has been considerable progress in knowledge during the past few years, in most cases the taxonomy, geographical distribution, reproductive biology and conservation status of these species is inadequately documented for appropriate management to be implemented.

Due to the coincidence of greatest areas of species richness and local endemism for the State with cereal-growing areas, highest priority has been given to research on endangered and poorly known flora of the wheatbelt and Swan Coastal Plain. Although field surveys of these areas and the annual review of declared rare flora remain high priority, it is also intended to increase research on the population biology and management of selected endangered flora with various life histories. This will be achieved by establishing permanent monitoring quadrats, undertaking population ecology/genetic studies and developing a computer data base on

endangered flora. The expected end product will be the preparation of declared rare flora management programs. In addition to these species' based programs, the development of regional and district based programs is also underway. Limited research will continue on more common flora where conservation problems are likely. These include effects of *Phytophthora* fungi and wildflower picking on banksias; fragmentation of the range of widespread eucalypts by clearing; impact of beekeeping; competition by weeds with keystone species, and impacts on granite outcrop species.

## ACHIEVEMENTS

Two Rare Flora Wildlife Management Programs - one for all rare flora in the Northern Forest Region and the other for the Rose Mallee (*Eucalyptus rhodantha*) - have been completed and will be released for public comment in mid 1989. These are the first Wildlife Management Programs to deal with rare flora and the program for the Northern Forest Region is the first in a series which will eventually cover all CALM regions.

The rare flora data base has been expanded and now consists of five categories of priority species in addition to the Declared Rare Flora. Updating the schedule of Declared Rare Flora has continued with the new list to be released in mid 1989.

## AIM

To provide scientific information that maximizes effective conservation and management of the flora of Western Australia.

## PRIMARY OBJECTIVES

### Rare and Endangered Flora

To undertake research on rare and endangered flora systematics, geographical distribution, genetics, population ecology and management techniques (e.g. fire, mechanical disturbance, weed competition, grazing regimes, pest and disease control, propagation and re-establishment in the wild). To recommend on land acquisition, management techniques, future research and conditions for Ministerial permits to take with a view to producing rare flora wildlife management plans. To prepare

wildlife management programs for species that require management.

#### Flora Data Base

To establish and maintain a data base on the geographical distribution and conservation status of Western Australia's native flora and plant communities.

#### Public Involvement

To foster a sympathetic public attitude to flora conservation through direct involvement of the public in appropriate research projects.

#### Wildflower Industry

To undertake research and provide advice with a view to producing wildlife management programs for plants used in the wildflower industry.

#### Communication

To communicate research results through scientific and technical publications, through advice and liaison with other CALM staff, other organisations and the public and through involvement in training and public conferences and seminars.

#### **20 YEAR GOALS (based on current resources and in priority order)**

1. Develop and maintain a comprehensive data base for declared endangered flora and other priority species and undertake surveys and implement findings on poorly known species at risk. \*\*\*
2. Prepare Wildlife Management Plans and establish a network of permanent monitoring quadrats for all declared endangered flora. \*\*\*
3. Involve the public in monitoring and surveys of all declared endangered flora and other groups of flora. \*\*
4. Provide management plans for all major species utilized in the wildflower industry, continue monitoring effects of the industry on native flora and undertake research on the management of selected priority species.\*

#### **5 Year Goals (with existing resources)**

1. Undertake field surveys of poorly known high priority species at risk, and review the schedule of declared rare flora annually.
2. Develop and maintain a computerized data base for declared rare flora and other priority species, and an ability to map geographical distributions using FLORAPLOT.
3. Produce 5 Endangered Flora Wildlife Management Plans that are either species, reserve or CALM Region based.
4. Establish a network of permanent monitoring quadrats on all species for which Endangered Flora Wildlife Management Plans are produced.
5. Produce a colour book on the Declared Endangered Flora and a review of rare flora conservation in W.A.
6. Carry out studies on the biosystematics and conservation status of Western Australian flora.
7. Publish the Orchid atlas.
8. Complete an endangered eucalypt atlas.
9. Seek public involvement in the monitoring of declared endangered flora.
10. Produce, through the letting of consultancies, three Wildlife Management Plans on species used in the wildflower industry.
11. Undertake research on the management of *Boronia megastima* and other priority species in relation to commercial harvesting techniques.
12. Conduct an annual review of the Australian National Parks and Wildlife Service's statistics on Western Australian cut flowers exported under legislative permit.
13. Review research priorities regarding the wildflower industry after proclamation of the proposed flora licensing amendments to the Wildlife Conservation Act.



14. Publish educational material, field guides to eucalypts and orchids of five national parks, and books on trees and tall shrubs of Perth and on orchid pollination.

15. Establish field herbaria in all CALM regional and district offices and ranger stations.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994**  
(numbers refer to the Table following)

4,8,9,10,11,12,13(part),17,18,21,23(part),24,25,27, 28,29,30,33

**PROPOSED NEW PROJECTS - with existing resources**

Nil

**PROPOSED NEW PROJECTS - with additional resources in priority order)**

Data base rare flora:3

Together with:

- Survey of endangered and poorly known flora of cereal growing areas undergoing active clearing. 1.0 Professional, 1.0 Technical officer; \$42 000 over 3 years.

This project will attempt to keep up with the pace of ongoing agricultural land clearance and focus on local endemics of the wheatbelt and urban areas, with a view to producing Wildlife Management Plans on the most endangered taxa.

- Survey of endangered and poorly known flora of the Karri region. 1.0 Professional, 1.0 Technical officer; \$27 000 over 2 years.

The precise locations and abundance of karri region endemics will be documented, with an emphasis on orchids and other herbs that have not received the detailed attention of CALM staff, and the aim of developing Wildlife Management Programs where appropriate.

- Biology and management of selected plants heavily exploited in the wildflower industry (including *Boronia megastigma*, *Banksia*

*coccinea*, *Dryandra polycephala* etc.). 1.0 Professional, 1.0 Technical officer; \$42 000 over 3 years.

The small number of heavily exploited species that may be at risk from commercial harvesting will be investigated with a view to preparing Wildlife Management Plans on each.

- Biology and control of invasive introduced environmental weeds. 1.0 Professional, 1.0 Technical officer; \$42,000 over 3 years.

This project will review what is known about invasive environmental weeds in W.A. rank them in terms of the threat they pose, and initiate studies on the control of a small number of the most serious problem taxa.

- Impact of beekeeping on native flora and fauna. 1.0 Professional, 1.0 Technical officer; \$70 000 over 5 years.

After an initial review of the problem, this project will focus on those plants and animals considered to be most at risk through the impact of apiculture, and plans for management of the industry of CALM lands will be developed.

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Coates, D.J., Yen, D.E. and Gaffey, P.M. (1988). Chromosome variation in taro, *Colocasia esculenta*: implications for origin in the Pacific. *Cytologia* 53: 551-560.

\*Coates, D.J. (1988). Gather no moss. *Landscape* 4: 54-55.

\*Coates, D.J. (1988). Genetic differentiation and dispersal in plants. Proceedings of the NATO advanced research workshop on population biology of plants at Port-Camarque. Book Review. *Aust. J. Ecol.* 13: 538-539.

Hopper, S.D. and Newbey, K.R. (1988). Plants of the Cocklebiddy-Eyre Region, Western Australia. In "Eyre Bird Observatory Report No. 4 1984-1985". RAOU Report No. 38, 82-90.

\*Keighery, G.J. (1988). Garden Escapes. *Landscape* 3: 44-48.

- \*Keighery, G.J. (1988). Environmental weeds of Western Australia. In: Proceedings of Workshop on Weeds on Public Lands. Monash University.
- \*Keighery, G.J. (1988). *Banksia brownii*. *Landscape* 3: 54.
- \*Sampson, J.F., Hopper, S.D. and James, S.H. (1988). Genetic diversity and the conservation of *Eucalyptus crucis* Maiden. *Aust. J. Bot.* 36: 447-460.
- \*Sampson, J.F., and Hopper, S.D. (1989). Field Guide, Survey of Rare and Poorly Known Poison Plants (*Gastrolobium*) of Western Australia. CALM, Perth.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90	
Rare and Endangered Flora	Field surveys Review schedule	1	Field surveys of rare and endangered flora Various staff	Several surveys completed	Continue surveys as time permits
		2	Additions and deletions Declared Rare Flora RS66 DJ Coates; SD Hopper, S van Leeuwen	New schedule through	Revise schedule
	Data base	3	Data base rare flora RS69 S van Leeuwen, DJ Coates; SD Hopper	Data base updated and partly computerized	Continue data acquisition/computerization
	4	<u>Eucalyptus caesia</u> SD Hopper	Field work completed	Submit for publication	
	5	<u>Eucalyptus macrocarpa</u> SD Hopper	Nil	Defer	
	6	<u>Eucalyptus camabyi</u> SD Hopper	Nil	Defer	
	7	Hybrid studies DJ Coates, SD Hopper	Continue field studies; start isozyme studies	Continue	
Wildlife Management Plans		8	<u>Acacia anomala</u> DJ Coates	Data collection complete	Publish management plan, inspect quadrats
		9	Northern Forest Region A Kelly & various Dept staff	MS near completion	Publish management plan
		10	<u>Drakaea jeanensis</u> SD Hopper	Permanent quadrats inspected	Continue quadrat work
		11	<u>Banksia cuneata/B. oligantha</u> DJ Coates	Data collection near completion	Publish management plan
		12	<u>Stylidium coroniforme</u> DJ Coates	Quadrats monitored, data collection near completion	Complete data collection, prepare management plan & inspect quadrats
			<u>Eucalyptus rhodantha</u> J Sampson, SD Hopper, DJ Coates	Management plan completed	Publish management plan
		13	Conservation genetics RS26. DJ Coates		
			<u>Banksia</u> species	Isozyme studies completed on 2 species, underway on 2 species	Prepare data for publication, continue isozyme studies
			<u>Grevillea</u> species	Material collected on all species Declared Rare	Commence isozyme studies
		14	Genetic systems RS26 DJ Coates	Studies initiated on 9 species	Continue
Rare flora publications		15	Life history, eco-geography RS26 DJ Coates, SD Hopper	Monitoring quadrats set up on popns of 20 species	Continue monitoring, set up quadrats on other species
		16	Germ plasm storage RS27 DJ Coates, J Armstrong	Seed collections started on 8 species	Continue seed collections, arrange long term storage
		17	Book on rare and endangered flora SD Hopper, S van Leeuwen	MS nearly complete, slides and drawings collated	Finish MS submit for publication

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90		
Flora Data Base	W.A. Flora general biology, conservation status, phylogeny	18 Review rare flora conservation in W.A. RS73 SD Hopper, DJ Coates	Literature review underway	Continue review		
		19 Public involvement rare flora Endangered eucalypt atlas A Napier, A Kelly, SD Hopper	All field guides completed and published. Several surveys undertaken	Continue survey, prepare report		
		20 Endangered poison plants survey J Sampson, SD Hopper, DJ Coates	Field guide completed, surveys initiated	Complete surveys, prepare report		
		21 <u>Eremaca</u> RS30 DJ Coates	Prepare MS	Submit MS for publication		
		22 <u>Tremandraceae</u> RS95 J Alford, G Keighery	Field data on computer. Honours project started	Complete field surveys; prepare Honours thesis		
		23 <u>Stylidium</u> DJ Coates	Field studies continued, finalized taxonomy/phylogenetics of <u>S. caricifolium</u> complex	Continue field studies prepare <u>S. caricifolium</u> MS for publication		
		24 Rapidly declining species RS30 DJ Coates	Complete isozyme/field studies on <u>B. ilicifolia</u>	Commence field/isozyme studies on tuart, prepare MS on <u>B. ilicifolia</u> and submit for publication		
		25 <u>Stylidium</u> hybridization RS31 DJ Coates	Complete isozymed chromosome studies	Prepare MS and submit for publication		
		26 Naturalized Flora GJ Keighery	Surveys of weeds of Banksia woodlands completed	Start surveys of Cape Naturalist Yanchep Nat. Parks. Complete MS		
		27 Orchids Stirling Range SD Hopper, A Brown	MS partly finished, illustrations collated			
		28 Orchid pollination book SD Hopper, A Brown	Nil	Prepare MS and submit for publication		
		29 Native trees Perth RS77 R Powell, SD Hopper	MS mostly written, illustrations prepared	Complete MS and submit for publication		
		Wildflower Industry	Management plans	30 Kangaroo paws RS72 SD Hopper	One M.App.Sci. thesis finished	Complete other M.App.Sci thesis, submit report to ANPWS
				31 Genetics, conservation status of 4 species RS29 DJ Coates	Material collected from <u>Banksia coccinea</u> for isozyme studies	Start isozyme studies
32 Management Plan <u>Anigozanthos pulcherrimus</u> , <u>Macropidia fuliginosa</u> SD Hopper	Data collection complete			Prepare for publication		
	Harvest and Boronia		33 <u>Boronia</u> utilization and distribution DJ Coates, SD Hopper	Nil	Prepare <u>Boronia</u> management plan	
	Review research after licensing changes	34 Licensing and management RS70 DJ Coates, SD Hopper	Wildflower Industry Review Committee report prepared; impact of picking on dieback investigated	Finalize report of Wildflower Industry Review Committee		

# HERBARIUM PROGRAM

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## PROGRAM LEADER

JA Armstrong

## CURRENT RESOURCES (1989/90)

This program comprises 17.85 persons (10.25 Professional + 1 Contract Professional + 4.10 Technical + 1 Contract Technical + 1 Wages). Its estimated CRF budget is \$669 464 (including \$602 114 salaries and \$67 350 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 18.20 persons (10.7 Professional + 1 Contract Professional + 4 Technical + 1.50 Contract Technical + 1 Wages). Its budget was \$933 547 (including \$606 547 Salaries and \$327 000 operating costs). High operating costs for 1988/89 were due to one off costs associated with the transfer of the Herbarium from the Department of Agriculture to CALM. Over \$80 000 was attracted in external funds during 1988/89. This was used to employ the contract staff and provide them with an operating budget (see Table 3).

## BACKGROUND

The Western Australian Herbarium was officially established (as the State Herbarium) in late 1928/early 1929 by the amalgamation of plant collections held by the W.A. Museum (specimens not incorporated into State Herbarium until 1959/1960), W.A. Forests Department and W.A. Department of Agriculture. Until 1988, when it was transferred to CALM, the Herbarium was administratively attached to the W.A. Department of Agriculture.

The Herbarium houses the State's principal reference collection of plant specimens, both native and naturalized. Currently the collection comprises some 400 000 specimens and has a replacement value of \$120 M. Its primary functions are to maintain and extend this collection and to provide internationally accepted names, based on scientific principles, primarily for plants occurring in Western Australia. This State has a very rich flora comprising about 8 000 described vascular plant species and an estimated 2 000 species undescribed. It also has a significant cryptogamic flora. The Herbarium's scientific research function of identification and

classification is essential for an understanding and management of the flora. Moreover, the geographic and other information contained in the Herbarium holdings provide a valuable information resource. The Herbarium is part of a national and international network and draws upon this resource to resolve questions concerning the names of plants occurring in this State.

By 1993 advances will have been made in the documentation of the flora of Western Australia. Many new plant species will have been named as a result of current taxonomic studies. The Flora of the Kimberley Region as well as other publications on the floristics of that region, will have been produced. Contributions on Asteraceae, Leguminosae, Myrtaceae, Rutaceae and other families will have been completed for the Flora of Australia project.

## ACHIEVEMENTS

The Herbarium was formally amalgamated into CALM and the process of integrating its functions with those of the Research Division commenced. A new interim Herbarium structure has been established to facilitate the integration process and to optimise productivity.

Two CALM Regional Herbaria were established at Albany and Manjimup; these, together with the Karratha Regional Herbarium, now form the nucleus of CALM's Regional Herbarium Network.

Herbarium Staff made significant contributions to the Kimberley Regional Flora Project as well as to two external projects: the Flora of Australia and the Flora of New South Wales.

Two significant collections were processed and incorporated into the Herbarium during the year. These were the Ken Newbey collection (5 000 specimens) and the University of Western Australia collection (15 000 specimens). The *Verticordia* Reference Collection, prepared by the *Verticordia* Study Group, was incorporated into the Herbarium's Community Reference Herbarium.

A number of important research papers were published during the year, including one interpreting biogeographic patterns in *Acacia*.

## AIM

To preserve, curate and extend the State's principal reference collection of native and naturalized plants and to conduct and assist plant taxonomic research in order to provide authoritative names and other taxonomic information essential for effective conservation and management of the flora.

## PRIMARY OBJECTIVES

Subsequent to the Herbarium's transfer to CALM a new sectional structure for the Herbarium was introduced in 1989. This is an interim measure until the Herbarium is structured on a program basis.

### Collections Section

To collect and maintain a comprehensive representation of the State's vascular and cryptogamic flora and to keep this collection in a state of curation that accords with current taxonomic opinion. To maintain and develop a comprehensive botanical library containing a collection of literature devoted to systematic botany as well as collections of original illustrations and photographic slides of the plant taxa of the State.

### Databases Section

To provide an inventory of the flora of Western Australia and to make taxonomic, geographic and ecological information contained in the Herbarium's specimen and taxon databases readily accessible, for the purposes of systematic research and the implementation of conservation strategies.

### Flora Information Section

To provide expert advice on plant taxonomy and nomenclature pertaining to native and introduced species, including toxic and weed species and those cited in legislation. To develop and maintain a comprehensive Community Reference Herbarium to encourage the public to identify their own specimens using keys and reference specimens. To maintain a taxonomic garden as an educational and research resource for use by the public and visiting taxonomists. To co-ordinate the production of the institution's scientific journals, floras, check-lists and extension publications.

### Regional Flora Section

To synthesize taxonomic knowledge and provide a ready means of identifying the plant taxa of Western Australia through the production of flora handbooks.

### Systematics Section

To conduct taxonomic research to discriminate and describe plant taxa. To undertake phylogenetic, phytogeographic and nomenclatural studies in order to provide re-assessments of classifications and determine taxonomic relationships. To present the results of botanical research in relevant publications.

## 20 YEAR GOALS (based on current resources and in priority order)

1. Make taxonomic and geographic information contained in the collections readily accessible. \*\*\*
2. Prepare taxonomic treatments of selected plant families for systematic and floristic publications and Flora of Australia. \*\*\*
3. Prepare regional Flora handbooks for the whole of Western Australia. \*\*\*
4. Extend the Herbarium collections so as to acquire a significant sample of the botanical diversity of Western Australia. \*\*
5. Improve the extension service to respond more effectively to relevant enquiries. \*\*

## 5 YEAR GOALS

1. Improve curatorial procedures and maintain Herbarium collections.
2. Expand Herbarium collections in designated taxonomic categories and geographic areas.
3. Extend the WA HERB specimen database.
4. Complete the latitude and longitude program for the WA HERB specimen database.
5. Maintain a census of W.A. plant names and develop it as an accessible computerized database.

6. Complete the Community Reference Herbarium.
7. Prepare revisions and allied studies of selected plant taxa.
8. Complete a checklist of naturalized flora of W.A. and establish a database.
9. Complete contributions for the Flora of Australia and Flora of N.S.W. in the families: Asteraceae, Leguminosae, Malvaceae, Myrtaceae, Polygonaceae and Thymelaeaceae.
10. Publish the Flora of the Kimberley Region.
11. Commence preparation of a south western Flora and publish a revised edition of the Flora of the Perth Region.
12. Complete floristic surveys of nominated regions.
13. Increase effectiveness of the plant identification and information service.
14. Publish the journals *Nuytsia* and *Kingia* twice each year.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994**

8,14,17,18,20-22,24,26-28,32-38,40-62,64-70,72,73,81,86-105,107-112,113-119,123,125-129,139-140.

**PROPOSED NEW PROJECTS - with additional resources**

Integrate Herbarium databases with other relevant CALM databases.

**PROPOSED NEW PROJECTS - with existing resources**

W.A. Regional Flora, south west region

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Armstrong, J.R. (1988). The Evolution of Flora Syndromes in the Australasian Rutaceae. Australasian Pollination Ecologists' Society Newsl. 1/88.

\*Bevalot, F, Armstrong, J.A., Gray, A.I. and Waterman, P.G. (1988). Coumarins from the

leaves *Phebalium squameum*. *Phytochemistry* 27: 1546-1547.

\*Bevalot, F., Armstrong, J.A., Gray, A.I. and Waterman, P.G. (1988). Coumarins from three *Phebalium* species. *Biochem. Syst. Ecol.* 16: 631-633.

\*Clarkson, J.R. and Kenneally, K.F. (1988). The Floras of Cape York and the Kimberley: A preliminary comparative analysis. *Proc. Ecol. Soc. Aust.* 15: 259-266.

\*Conn, E.E., Seigler, D.S., Maslin, B.R. and Dunn, J. (1989). Cyanogenesis in *Acacia* subgenus *Aculeiferum*. *Phytochemistry* 28: 817-820.

Groeneveld, K.M. and Armstrong, J.A. (1989). Conservation biology of the Endangered species *Hibiscus insularis*. World Wildlife Fund (Australia) Project 65: Final Report, January 1989.

\*Hnatiuk, R.J. and Maslin, B.R. (1988). Phytogeography of *Acacia* in Australia in relation to climate and species-richness. *Aust. J. Bot.* 36: 361-363.

\*Jakupovic, J. Schuster, A., Bohlmann, F., King, R.M. and Lander, N.S. (1988). Sesquiterpene lactones from *Gnephosis* species. *Phytochemistry* 27: 3181-3185.

\*Keighery, G.J. (1988). *Tazetta Narcissus* naturalized in Western Australia. *Aust. Syst. Bot. Soc. Newsl.* 58: 13-14.

\*Keighery, G.J. (1988). Taxonomy of the *Xanthosia fruticulosa* group (Apiaceae). *Nordic. J. Bot.* 8: 445-446.

\*Keighery, G.J. (1988). Breeding systems of the Western Australian flora III Aizoaceae. *W.Aust. Nat.* 17: 121-125.

\*Keighery, G.J. and Dixon, I.R. (1988). "*Rinzia*". *Australian Plants* 14: 220-224.

Keighery, G.J. and Dixon, I.R. (1988). The Genera *Angasomyrtus*, *Homalospermum*, *Malleostemon*, and *Pericalymma*. *Australian Plants* 14: 154-159.

\*Keighery, G.J. (1988). A new species of *Samolus* (Primulaceae) from Western Australia. *Nordic. J. Bot.* 8: 329-330.

- \*Kenneally, K.F. (1988). *Grevillea donaldiana* (Proteaceae), a new plant species from the Kimberley Division of Western Australia. *W.Aust. Nat.* 17: 111-117.
- \*Kenneally, K.F. (1988). Obituary: Ken Newbey (1936-1988). *W.Aust. Nat.* 17: 127-128.
- \*Lander, N.S. (1989). The Tasmanian plant collecting localities of Ronald Gunn and Joseph Milligan - additional records. *Austral. Syst. Bot. Soc. Newsl.* 57: 7-10.
- \*Lander, N.S. and Walsh, N.G. (1989). *Olearia astroloba* (Asteraceae: Astereae), a new species endemic to Victoria. *Muelleria* 7: 123-125.
- \*Lander, N.S. (ed.) (1988). Census of the Vascular Plants of Western Australia. Cumulative Supplement 7. 40pp.
- \*Maslin, B.R., Dunn, J.E. and Conn, E.E. (1988). Cyanogenesis in Australian species of *Acacia*. *Phytochemistry* 27: 421-428.
- \*Maslin, B.R. and Pedley, L. (1988). Patterns of distribution of *Acacia* in Australia. *Aust. J. Bot.* 36: 385-393.
- \*Maslin, B.R. (1989). Wattle become of *Acacia*? *Aust. Syst. Bot. Soc. Newsl.* 58: 1-13.
- \*Maslin, B.R. and Court, A.B. (1989). *Acacia caerulescens*, a new species of *Acacia* section *Phyllodineae* from Victoria. *Muelleria* 7: 131-134.



Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90	
Collections	Maintain Herbarium collections	1	Curation of collections PG Wilson, S Curry, PS Spencer, CM Parker	Incorporation of new & revised specimens. Updating of nomenclature. Monitoring of specimen order, maintenance & insect control. Loans of specimens. Specimens named; retained where appropriate.	As for 1987/88 & provide extra storage facility.
		2	Name incoming specimens & retain suitable ones for herb. PERTH. S Patrick, B Koch RJ Cranfield, all Botanists		Continue as for 1987/88.
		3	Mount, label, etc. specimens retained at herb. PERTH. S Curry, PS Spencer	Specimens processed.	Continue as for 1987/88.
		4	Photograph Type specimens. RJ Cranfield	Loan specimens photographed.	As above.
	Maintain and develop WAHERB specimen database.	5	Compile annotated catalogue of floristic lists available for WA regions KF Kenneally	New project	To catalogue the published floristic lists
Provide index to information on taxonomy of W.A. plants.		6	Develop index systems. PG Wilson; Librarian	Index cards prepared for current year.	Continue
		7	Leopold Range: Survey PG Wilson, RJ Cranfield, DG Goble-Garratt	Processing, identification & incorporation of collections partially completed	Prepare MS
		8	WA Dept Agric rangeland surveys RJ Cranfield	Survey of Murchison/Greenough River catchment areas, & one Goldfields area completed, material collected, processed & identified.	Produce species list
		9	List of plants of the Pilbara RJ Cranfield	Added records to list	Continue updating list
Maintain and develop WAHERB specimen database		10	Managing WAHERB specimen database BR Maslin, J Armstrong, JW Searle, NS Lander	Maintenance of system achieved. New hardware requirements assessed. User Guide, User Manual & latitude/longitude program commenced. Unix course attended	Replace existing hardware. Assess new software. Complete User Guide, Manual & lat./long. program & implement appropriate procedures. Re-design specimen Insertion Form.
Maintain and develop WAHERB specimen database		11	Specimen entry into WAHERB. JW Searle, CM Parker	Existing entries updated. Family Rutaceae commenced.	Update existing records as required. Complete Rutaceae.
Maintain and develop Census of W.A. plant names.		12	Maintain a current census of the flora of Western Australia. Capture new records and update records as required. G Perry, JA Armstrong	November supplement compiled & published	Ongoing maintenance of database
		13	Develop data base from current Census files. JA Armstrong, G Perry	PRIME files downloaded to IBM-PC. Specifications of current data determined, data-entry sheet designed.	Restructure PRIME text files to form free-field data files. Assist in data analysis & design of database.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
Systematics	Checklist & database of naturalized flora of WA	14 Publication of annotated checklist of the naturalized flora of WA G Perry	Researched & modified checklist as necessary.	Continue writing nomenclatural notes with emphasis on Poaceae. Research & modify checklist as necessary. Transfer database from PRIME to PC.
	Revisionary studies: (a)	15 General systematics RS97 GJ Keighery	Liliaceae complete	Opercularia commenced
	(b) Aristolochiaceae	16 <u>Aristolochia</u> KF Kenneally	Field work conducted	Prepare MS for single species
	(c) Asteraceae: Astereae	17 <u>Campytrachia</u> : nomenclature. NS Lander	Paper published.	-
		18 <u>Minuria</u> : revision. NS Lander	Paper published.	-
		19 <u>Olearia</u> : revision. NS Lander	Paper concerning <u>O. stuartii</u> complex paper in press; proofs corrected.	Paper in press.
			Two papers describing new species from Tas. & Vict. published	
			<u>O. axillaris</u> group tentatively elucidated from herbarium specimens.	Field work, Perth - Shark Bay; complete paper.
			<u>O. pimeleoides</u> group elucidated.	Complete paper.
			Completed & submitted paper describing 7 new species from WA.	Correct proofs.
		Completed & submitted paper concerning <u>O. rapae</u> (SE Polynesia) placing it in a new genus, <u>Apostates</u> ; proofs corrected.	Paper in press.	
			Prepare paper on <u>O. pannosa</u> group (a new genus).	
(d) Asteraceae: Heliantheae	20 <u>Xanthium</u> : taxonomy, nomenclature. G Perry, P Michael, Sydney.	Examined material at herb. Descriptions of 4 species completed. Wrote to numerous institutions in a search for the original material of a number of <u>Xanthium</u> names (esp. those published by Walther). Obtained photos of the type of <u>X. americanum</u> , <u>X. brasiliense</u> and <u>X. californicum</u> .	Continue to search for original material of relevant names. Investigate typification. Write dissertation on the classification of <u>Xanthium</u> . Field work in California (PW Michael). Submit for publication paper on the typification of <u>X. strumarium</u> L. & <u>X. orientale</u> L.	
(e) Asteraceae: Inuleae	21 <u>Helipterum</u> - <u>Helichrysum</u> generic classification. PG Wilson	Assessment of morphological characters; grouping of taxa. Papers in press on <u>Erymophyllum</u> & <u>Hyalosperma</u> . Proofs corrected	Complete MS of selected genera.	
	22 <u>Taplinia</u> : a new genus. NS Lander		Paper in press.	
(f) Boraginaceae	23 <u>Halganina</u> : revision. KF Kenneally	Field studies.	Ongoing	

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
(g) Chenopodiaceae		24 Generic classification. PG Wilson	Paper published.	Ongoing.
		25 <u>Halosarcia</u> : taxonomy. PG Wilson.	-	Collect material of the known but undescribed species.
(h) Colchicaceae		26 <u>Wurmbea</u> : taxonomy. TD Macfarlane	-	Prepare MS describing a new species.
(i) Dasygongonaceae		27 <u>Chamaexeros</u> : taxonomy. TD Macfarlane	Draft MS prepared of a new species.	Complete MS & submit for publication.
(j) Dilleniaceae		28 <u>Hibbertia</u> : revision of subsect. Tomentosae in northern Australia. JR Wheeler	Database of label information maintained; elucidation of taxa continued	Proceed with elucidation of taxa
		29 <u>Hibbertia</u> : south-western species. JR Wheeler	Field studies and collections of new taxa made from northern wheatbelt	Collection of poorly known taxa in wheatbelt.
		30 <u>Hibbertia</u> : publication of new taxa. JR Wheeler	One MS completed and submitted for publication.	<u>Hibbertia hooglandii</u> published; circumscription of new taxa.
(k) Droseraceae		31 Description of new taxa. NG Marchant	Draft descriptions prepared	Complete MS
		32 Revision of infrageneric classification of Drosera. NG Marchant, D Goodall (CSIRO).	Data entered and computer analysis completed	Prepare draft paper on revised infrageneric classification.
(l) Haemodoraceae		33 <u>Haemodorum</u> : revision. TD Macfarlane	-	Complete specimen examination, prepare outline of paper.
(m) Leguminosae: Mimosoideae		34 <u>Acacia</u> sect. Phyllodineae: taxonomy. BR Maslin & AR Chapman	MSS completed for <u>A. ligulata</u> , <u>A. victoriae</u> and <u>A. wilhelmiana</u> groups. <u>A. veronica</u> MSS completed. <u>A. caerulea</u> MSS published.	Publish completed MSS. Prepare MSS for miscellaneous new spp.
		35 <u>Acacia</u> sect. Plurinerves: taxonomy. BR Maslin & RS Cowan	3 MSS completed	Publish completed MSS. Prepare MSS for miscellaneous new spp.
		36 <u>Acacia</u> sect. Juliflorae: taxonomy. BR Maslin & AR Chapman	4 new spp. described in MSS	Prepare MSS for additional new spp.
		37 <u>Acacia</u> : assessment of generic status. BR Maslin et al.	Paper published. Maintained liaison with collaborators.	Encourage multi-disciplinary approach to assess generic status of <u>Acacia</u>
		38 <u>Prosopis</u> : identification of naturalized species. G Perry	Preliminary examination of material on loan from NSW and Qld	Continue work to determine natural groups for NSW & Qld material. Continue investigation into origin of <u>P. pallida</u> material naturalised in Australia.
(n) Leguminosae: Papilionoideae		39 <u>Pultenaea</u> in W.A.: revision. TD Macfarlane	Field work conducted. Further studies on difficult species.	Resolve taxonomy of difficult species-groups; describe new taxa.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
		40 <u>Pultenaea</u> : review of generic limits. TD Macfarlane	Further data gathering accomplished	Complete data scoring; partially analyse data.
(o) Loganiaceae		41 <u>Logania</u> : taxonomy. G Perry	-	Annotate AD material.
(p) Malvaceae		42 <u>Plagianthus</u> alliance: revision. NS Lander	No further progress	
(q) Myrtaceae		43 <u>Actinodium</u> : revision. NG Marchant, GJ Keighery	Draft MS completed	Submit for publication
		44 <u>Agonis</u> : revision. NG Marchant	Study of type specimens. Study of variation. Study of herbarium collections in MEL.	Prepare draft MS.
		45 <u>Chameaucium</u> : revision. NG Marchant, GJ Keighery	MS transferred to disk; circumscription of taxa and study of generic limits completed.	Complete MS & submit for publication.
		46 <u>Darwinia</u> : description of new taxa. NG Marchant, GJ Keighery	Herbarium material sorted; grant for technical assistance applied for.	Prepare descriptions for publication
		47 <u>Pileanthus</u> : revision. NG Marchant, GJ Keighery	New taxa sorted; distribution data gathered; field work planned.	Prepare MS for publication.
		48 A new series of <u>Rigentes</u> of <u>Eucalyptus</u> (Myrtaceae) comprising 3 new species endemic to WA SD Hopper	In press	
		49 <u>Beaufortia</u> , <u>Regelia</u> RS8 AA Burbidge	Field surveys near completion	Check types, prepare MS
		New <u>Eucalypts</u> /taxonomy RS81SD Hopper	Field studies completed, glasshouse studies initiated.	Complete glasshouse studies, prepare MS.
		50 <u>Eucalyptus wandoo</u> and allies RS80 SD Hopper	Field studies of 3 new taxa, MS partly written.	Complete MS & submit for publication.
(r) Orchidaceae		51 <u>Caladenia</u> , <u>Drakaea</u> SD Hopper	Field collections finalised, herbarium data collected	Write up & submit to Nuytsia.
		52 <u>Caladenia</u> , <u>Choraea</u> RS79 SD Hopper	MS revised	Submit for publication
(s) Proteaceae		53 <u>Grevillea</u> : taxonomy. KF Kenneally	New species published.	-
(t) Rutaceae		54 <u>Boronia</u> , <u>Eriostemon</u> : taxonomy PG Wilson	-	Describe new taxa.
(u) Styliidiaceae		55 <u>Styidium</u> : taxonomy. KF Kenneally	Description of a new species completed.	Submit for publication.
		57 Creeping Trigger plants RS18 AH Burbidge	Further fieldwork carried out	Prepare MS

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
	(v) Thymelaeaceae	58 Revision of W.A. taxa. BL Rye	New material studied	Project continuing.
	(w) Xyridaceae	59 <u>Xyris</u> : Revision of S.W. species and tropical Australian species NG Marchant	Identification of Kimberley taxa completed.	Completion of MS for Flora of Kimberley Region; circumscription of South Western taxa.
Flora of Australia treatments: (a) Asteraceae: Astrecae		60 <u>Camptacra</u> NS Lander	Draft compiled	Submit
		61 <u>Kippistia</u> NS Lander	Draft compiled	Submit
		62 <u>Minuria</u> NS Lander	Draft compiled	Submit
		63 <u>Olearia</u> NS Lander	Descriptive data recorded for further 14 WA species	Record data for remaining 14 WA species & for ca. 20 ES species
			Locality coordinates calculated for collections at AUCK, BH, BRI, CANB, CHR, DNA, G, HO, L, PERTH.	Complete calculations for other herbaria. Enter all coordinates in database.
		Field work undertaken in SW WA.	Field work in Vict. & NSW to study <u>O. phlogopappa</u> and <u>O. ramulosa</u> groups. Illustrate 20 WA species & 20 ES species. Complete design and implementation of DELTA database system. Complete design and implementation of dBSL specimen database.	
		Application for continued ABRS funding successful (\$11 918)		
		Submitted application for further funding (\$67 000 over 3 years)	Submitted application for further funding (\$67 000 over 3 years)	Submit application for continued ABRS funding.
	(b) Asteraceae: Inuleae	64 <u>Helipterum</u> - <u>Helichysum</u> group PG Wilson	MS prepared of genera <u>Rhodanthe</u> , <u>Pteropogon</u> & <u>Monencyanthes</u>	Complete MS of genera in <u>Helichysum</u> group
		65 <u>Taplinia</u> NS Lander	Completed	Submit
	(c) Asteraceae: Mutiseae	66 <u>Trichocline</u> NS Lander	No progress	Prepare draft MS.
	(d) Leguminosae: Mimosoideae	67 <u>Acacia</u> sect. Phyllodineae. BR Maslin & AR Chapman	Flora descriptions prepared.	Complete Flora descriptions & key to species, commence illustrations.
		68 <u>Acacia</u> sect. Juliflorae. BR Maslin & AR. Chapman	Few Flora descriptions prepared. Prepared ABRS application for continued funding.	Prepare Flora descriptions for agreed taxa.
		69 <u>Acacia</u> sect. Alatae. BR Maslin	-	Sort.
		70 <u>Acacia</u> sect. Pulchellae. BR Maslin	-	Sort.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
	(e) Leguminosae: Papilionoideae	71 <u>Pultenaea</u> group. TD Macfarlane	-	Action dependent on completion of precursor projects.
	(f) Malvaceae	72 <u>Plagianthus</u> alliance. NS Lander	-	Prepare draft MS.
	(g) Polygonaceae	73 <u>Polygonum</u> s. str. G Perry	Preliminary examination of material on loan.	Continue study of material on loan in order to determine natural group.
	(h) Rutaceae	74 WA Rutaceae JA Armstrong PG Wilson	-	Prepare draft MS
	(i) Thymelaeaceae	75 Thymelaeaceae. BL Rye	MS updated.	Publication
Flora of NSW treatments: (a) Asteraceae: Astereae.	76	<u>Kippistia</u> . NS Lander	MS completed, submitted & accepted.	-
	77	<u>Minuria</u> . NS Lander	MS completed, submitted & accepted.	-
	78	<u>Olearia</u> . NS Lander	Descriptions of 37 species completed.	Complete descriptions of remaining 13 species; compile generic description; devise key; submit.
(b) Asteraceae: Inuleae	79	<u>Helipterum</u> . PG Wilson	MS prepared.	-
Flora of Central Australia treatments:	80	Numerous taxa. (various staff)	MS submitted & accepted.	-
	81	International Seed Testing Association: 3rd Edition of Stabilized Plant Names. PG Wilson	New names checked for adding to list.	Check names when received.
	82	Special Committee on Lectotypification. G Perry	-	Comment as member of Special Committee on Lectotypification as required.
	83	Submit proposals to change ICBN for 1993 Tokyo IBC. G Perry, J McNeill, Edinburgh	Continued work on typification of <u>Lycopersicon esculentum</u> , <u>Amsinckia</u> , <u>Panicum glaucum</u> . Draft MS prepared on typification of <u>Panicum glaucum</u> .	Continue study of nominated taxa.; prepare proposals to change the code. Send paper on typification of <u>Panicum glaucum</u> to colleagues for comments.
	84	Lists of Names in Current use & Registration of Names.	Organised Herbarium Workshop to discuss the feasibility & desirability of "Lists of Names in Current Use" & Registration of Names. Attended IUBS Workshop in Canberra in Oct. 1988 entitled "Whose Name? What Specimen".	Maintain dialogue with the Special Committee, preparing lists of names in current use.
	85	Nomenclatural status of <u>Acacia prominens</u> & <u>A. fimbriata</u> . G Perry & BR Maslin	Problem circumscribed & MS commenced.	Complete MS
	86	Elucidation of taxonomic problems associated with checklist. G Perry		
	87a	<u>Cytisus proliferus</u> , <u>Hypochaeris</u> , & <u>Lactuca</u> ; assess taxonomic status. G Perry	Field studies on <u>Lactuca</u> & <u>Hypochaeris</u> .	Continue field studies on <u>Lactuca</u> & <u>Hypochaeris</u> .

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
		87b <u>Diploaxis</u> : assess taxonomic status. G Perry, J McNeill, Edinburgh	Library work associated with discerning the correct name for the taxa presently known by the name <u>D. muralis</u> , <u>D. tenuifolia</u> .	Continue work on ascertaining correct name for the taxon to which the name <u>D. tenuifolia</u> is presently applied. Prepare draft MS on typification of names <u>Sisymbrium murale</u> L. (1753), <u>S. murale</u> (1763), <u>S. vimineum</u> L. (1753), <u>S. vimineum</u> (1763) and application of name <u>D. muralis</u> .
		87c <u>Leontodon</u> : application of species names. G Perry	-	-
		87d <u>Medicago murex</u> : application of species names. G Perry	Two taxa involved. The name <u>M. murex</u> has been adopted for one. Extensive library work carried out to determine possible names for second taxon. Type specimen examined at herb. P, G-DC & BM.	Incorporated information on name of second taxon into MS.
		87e <u>Paspalum</u> : application of species names. G Perry	Specimen examined at P.	Finalise MS & submit for publication.
		87f <u>Spergularia</u> : application of species names. G Perry, J McNeill, Edinburgh	Prepared outline of problem. Had discussion with J McNeill on problems associated with typification of names involved.	Examine specimens at herb. LINN & BM.
	Phytochemical studies.	88 <u>Cyanogenesis</u> in <u>Acacia</u> subgenus <u>Aculeiferum</u> . BR Maslin et al	Proofs corrected.	Publish
		89 <u>Cyanogenesis</u> in <u>Acacia pulchella</u> . BR Maslin & EE Conn, U.S.A.	-	Publish.
		90 <u>Gnephosis</u> NS Lander, F Bohlmann, W. Germany, RM. King U.S.A.	Paper published.	-
		91 <u>Phebalium</u> sens. lat. JA Armstrong, P Waterman, Scotland	-	Collect further material for collaboration.
	Evolutionary studies.	92 <u>Plagianthus</u> alliance. NS. Lander, DE Bates, U.S.A	-	Prepare paper on evolution of Australian & New Zealand species.
		93 Tribe <u>Boroniaeae</u> ( <u>Rutaceae</u> ) JA Armstrong	-	Prepare publication.
	Reproductive biology.	94 <u>Pseudo-chactochloa</u> : describe dioecy. TD Macfarlane, M Lazarides, Canberra	Illustrations prepared.	Complete MS & submit for publication.
		95 <u>Acacia</u> survey of hybridity. BR. Maslin et al.	-	Submit for publication.
	Botanical history.	96 Aiton's Hortus Kewensis: author citation & the contribution of R Brown to the Hortus Kewensis. G Perry & BR Maslin	Library work to assess historical view.	-

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
		97 Brown, R: Aiton's Hortus Kewensis contribution. BR Maslin	-	Complete & submit MS.
		98 Consett-Davis, HF: Walcott Inlet collections & biography. KF Kenneally	Identify plants and additional records extracted from Herbarium.	Complete MS.
		99 Cunningham, A: coastal collecting localities. S Curry & BR Maslin	MS completed & submitted.	Publish
		100 Cunningham, A: journal transcriptions. KF Kenneally	Additional transcribing of journals from microfilm.	Ongoing re-visit Cunningham collection localities.
		101 Checklist of obscure W.A. historical collecting localities. NG Marchant	Draft MS prepared.	Complete MS & submit for publication.
		102 Dorrien-Smith, A.A.: Plant collection from south-west W.A. KF Kenneally	Localities identified.	Ongoing as time permits.
		103 Fitzgerald, W.V.: diary. KF Kenneally	Further editing & field surveys carried out.	Edit MS and prepare biography.
		104 Gould, J/Gilbert, J: Plant collecting in the Swan River Colony. KF Kenneally	Further editing & archival documents examined.	Edit MS for publication.
		105 Hochreutiner, B.P.G.: Kimberley Plant Collections KF Kenneally	Field work carried out in Broome also archival records traced.	Liaise with Broome Botanical Society in preparing MS.
		106 Kimberley Plant Collectors. KF Kenneally	Compile historical dossiers on routes traversed, locate correspondence & photographs in relevant libraries and herbaria. Paper published.	Opportunistic..
		107 Preiss, J.A.L.: Asteraceae specimens collected in W.A. NS Lander		-
		108 Preiss, J.A.L.: collecting localities. NG Marchant	Paper prepared, submitted and accepted for publication.	Publication.
		109 Tepper, J.G.O.: 1889 Roebuck Bay collections. KF Kenneally	Data added to MS. Additional herbarium specimens located.	Examine Tepper specimens at herb. MEL; prepare MS.
		110 Turczaninow, N.S.: Contribution of Turczaninow to Australian Taxonomy. NG Marchant	Paper prepared, submitted & accepted for publication.	Publication.
		111 W.A. Botanists: Checklist of names & collecting localities. NG Marchant	Further data added.	Continue data collection.
		112 Gunn, RC & Milligan, J: Tasmanian collecting itineraries NS Lander	Published	



Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
Regional Floras	Flora of the Kimberley Region.	113 Flora text preparation, editing & co-ordination of project. JR Wheeler	Preparation of flora descriptions continued; preliminary editing and co-ordination continued.	Complete preparation of flora descriptions; complete editing; prepare family key & introduction.
			Preliminary editing of 13 families.	Finalize.
		114 Flora text preparation & editing. BL Rye	Co-ordination of project. Preparation of flora descriptions continued.	Continue. Complete flora descriptions; assist with editing.
		115 Flora text preparation and editing. B Koch	Preparation of flora descriptions continued.	Complete flora descriptions.
		116 Flora text preparation of ferns & fern allies, <i>Xyris Drosera</i> . NG Marchant	Draft descriptions of ferns & fern allies prepared.	Complete descriptions and prepare keys.
		117 Flora text preparation of Poaceae & other families TD Macfarlane	Poaceae partly completed.	Complete treatments.
		118 <i>Acacia</i> : sort taxa & prepare key to species. BR Maslin & G Leach, Darwin	Sort completed.	Prepare key.
		119 Flora text preparation of Chenopodiaceae. PG Wilson	MS completed.	
		120 New records of Kimberley plants. KF Kenneally, S Patrick, RJ Cranfield, other staff	New records communicated to relevant staff. See also under projects 114-122.	Continue recording species occurrences.
		Flora of the Perth Region update of publication.	121 Maintain record of corrections, additions, etc. for next edition NG Marchant, JR Wheeler	Corrections, changes and additions recorded.
122 New records of Perth Region plants. S Patrick, RJ Cranfield, other staff	Preliminary development of method of data capture.		Present data to enable informed decision regarding Flora format, boundaries, etc.	
South west Regional Floras.	123 Definition of scope of proposed Flora. NG Marchant : flora writers: other staff	Information on various Flora publication formats gathered; data on geographical coverage collected.	Planning workshop to be arranged for September 1989.	
Flora Information.	Provide identification/enquiry service.	124 Provide services as required. S Patrick, B Koch RJ Cranfield, all other staff	As required.	As required.
	Disseminate information on plants of W.A.	125 Toxic legumes of W.A.: revise booklet. S Patrick	Flowering material for one species collected, index continued.	Collect flowering material for further species & continue index.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
		126 Prepare information leaflets on the following: Blackboys/Blackgins; edible fungi; garden plants causing allergies; Herbarium garden. S. Patrick, B Koch, KF Kenneally	Preliminary research commenced. Herbarium garden species list completed.	Continue gathering information. Publish Herbarium Garden Booklet.
		127 Tree planting on wheatbelt farms : revise leaflets. S Patrick	-	Revise nomenclature & content of existing leaflets, update information.
		128 Kimberley rainforests. KF Kenneally	Articles published.	-
		129 Acacia: uses for arid/subtropical species. BR Maslin, L Thompson, Canberra	Draft MS prepared.	Submit for publication.
		130 Database of naturalised flora presented for identification S Patrick, G Perry	Database commenced and preliminary list produced.	Prepare draft list of Western Australia's Worst Weeds.
		131 Slide collection - environmental weed species S Patrick, R Cranfield	Collection commenced.	Continue adding slides from specimens brought for identification.
Provide education service.		132 Plant identification courses. S Patrick, B Koch, NS Lander, RJ Cranfield, other staff	Prepared and tutored two day plant identification course at CALM Manjimup.	Provide plant identification courses as required.
		133 Public lectures. Various staff	Numerous talks presented.	As required.
		134 Displays & exhibits. All staff	Numerous exhibits of Herbarium research activities presented.	As required.
		135 Herbarium & living collection tours. S Patrick, RJ Cranfield KF Kenneally	Numerous tours conducted.	As required.
		136 Information booklet on the role of the Herbarium S Patrick, B Koch, KF Kenneally, all other staff	Staff & Herbarium photos commenced.	Liaise with Programme Leaders to complete text & organise photographs for publication. Publish Booklet in Dec. '89.
		137 Teaching Plant Taxonomy at UWA. TD Macfarlane	Lecture & practical course presented.	No further involvement.
		138 Teaching Plant Taxonomy at Murdoch University. NG Marchant	1988 Lecture & practical Taxonomy course presented.	No further involvement.
		139 Supervision of Ph.D. project on <u>Astroloma</u> . TD Macfarlane, NG Marchant, WA Loneragan, UWA	Frequent supervisory meetings held.	Continue supervision as required.
		140 Supervision of Honours project on <u>Stypandra</u> . TD Macfarlane, SH James, UWA	Completed.	-

Primary Objective	5 Year Goal	Projects	Tasks Completed 1988/89	Targets 1989/90
	Review environmental reports & provide conservation advice.	141 Miscellaneous. Various staff	Plans reviewed.	As required.
	Produce W.A. herbarium scientific journals.	142 Nuytsia. NS Lander, TD Macfarlane, NG Marchant, JW Searle	Nuytsia 6(3) published.  7(1) fully edited & proofs corrected.  7(2) Several papers fully edited; others awaiting author's corrections.  7(3) single paper: author's corrections received.	In press.  Publish  Publish.
		143 Kingia. G Perry, B Koch, S Patrick, JW Searle	Kingia 2(1): 1 paper awaiting referee's report.	Publish 7(3). Publish 3 issues.
	Maintain & extend Community Reference Herbarium	144 Extend & update specimen records. S Patrick, other staff	Specimens added to Reference Herbarium.	Continue as for 1987/88. Investigate using photographs/drawings in place of species not represented.

# MARINE CONSERVATION PROGRAM

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## PROGRAM LEADER

JA Stoddart

## CURRENT RESOURCES (1989/90)

This program comprises 1.90 persons (1.40 Professional + 0.50 Technical). Its estimated CRF salary budget is \$78 368. An operating budget for the program had not been determined at the time of publication.

## RESOURCES IN PREVIOUS YEAR

The program commenced in December 1988. Resources for 1988/89 comprised 0.5 Professional staff. Its budget was \$32 000 (including \$23 000 salary and \$9 000 operating costs).

## BACKGROUND

Marine ecosystems within Western Australian waters present a diverse array of environments, from the cold waters of the Recherche Archipelago to the coral reefs and mangrove communities of the north. CALM has initiated a program which aims to establish a system of marine parks and marine nature reserves which will conserve representatives of these many habitats and their flora and fauna. Present knowledge of the distribution and abundance of these resources is rudimentary, as is our understanding of the processes important to their conservation.

In addition to matters related to its marine estate, CALM has responsibility under the Wildlife Conservation Act for many marine organisms, including marine vertebrate fauna, invertebrates in some areas, seagrasses and marine algae. Decisions affecting the conservation of these species need a wide variety of scientific advice and often require specific research. Research projects which have been initiated amongst various CALM Divisions will benefit from a centralised focus from within Research Division.

The Marine Conservation Program was initiated in late 1988 to develop a capacity for marine research within CALM and to provide a focus for the co-ordination of marine research of relevance to CALM objectives. Its formation recognises the growing importance of marine conservation within

CALM and Western Australia in general. The initial emphasis of the Program will split between survey work to compile resource inventories and studies of processes to aid park management and monitoring.

## ACHIEVEMENTS

A major research and monitoring program has been established at Ningaloo Marine Park, including a survey of the entire Ningaloo Reef to examine the predator-prey relationship of *Drupella* and corals.

## AIM

To ensure that scientific advice on the marine environment is available to CALM managers and planners.

## PRIMARY OBJECTIVES

### Co-ordination

To co-ordinate marine research originating from regions and divisions to ensure that it is:

- relevant to management objectives,
- scientifically sound,
- original,
- integrated with other research within and without the Department.

### Liaison

To liaise with State and Federal Authorities and tertiary institutions undertaking marine research within Australia to maximise the benefit of this research to marine conservation in WA and make certain that the results are promulgated within relevant CALM divisions.

### Facilitation

To identify sources of potential funding for marine research within CALM, apply for, and assist other CALM divisions to apply for such funds. To assist other agencies to undertake research of relevance to CALM by making available CALM resources.

### Field Research

To undertake selected research projects aimed at providing CALM with an inventory of marine resources of conservation significance and a better understanding of the marine environment and how it can be managed. Includes:

- development of computer-based geographic information system for marine resources (in collaboration with EPA and Fisheries);
- development and evaluation of monitoring programs in marine reserves;
- other programs to be developed from management priorities for CALM's marine estate.

### Extension

To promote the role of CALM in marine conservation within the State and Federal Government and the WA public.

#### **20 YEAR GOALS (based on current resources and in priority order)**

1. Provide a solid scientific basis on which to base management of CALM's marine estate.
2. Produce a geographic information system of WA's marine resources of significance to conservation which will allow objective operation of reserve selection criteria and

assessment of impacts on the conservation of wildlife.

3. Develop monitoring protocols with well-based indicators for the success of management strategies for CALM's marine responsibilities.
4. Create a favourable profile for CALM's marine research at national and international level.

#### **5 YEAR GOALS (based on current resources and in priority order)**

1. Develop monitoring systems to document baseline data and measure change within the biota of marine parks and reserves.
2. Accumulate data on marine resources of significance to conservation within WA waters.
3. Implement an effective co-ordination mechanism for marine research within CALM.
4. Provide a central focus for marine conservation research in Western Australia.
5. Represent CALM's marine interests amongst other State and Federal Departments and the general public.

#### **PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)**

7,8,10

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
Co-ordination	Co-ordinate research within CALM	1 Research Priority Plans J Stoddart	-	Prepare RPP
Field Research	Develop monitoring systems	2 Ningaloo <del>Drupella</del> J Stoddart	Broadscale survey of Ningaloo Reef completed	Prepare RPP; complete data analysis
		3 Seagrass monitoring J Stoddart		Prepare RPP
		4 Water quality monitoring J Stoddart		Prepare RPP
		5 Reef Assessment J Stoddart		Prepare RPP
		6 Recreational Fishing Survey J Stoddart		Prepare RPP
		7 Marine turtle conservation RS144-145,132-133 RIT Prince	External funding secured, field program executed, recovery of turtles documented, Aboriginal communities involved in work, continuation funding sought. Project now letter circulated	Proceed with development of project as specified. Include collaborative work with University of Queensland on population genetics
8 Dugong conservation RS 142-144 RIT Prince	Salvage specimens collected; limited progress made on data analysis of previous studies. Proposal for detailed population survey Shark Bay and Exmouth Gulf prepared and funding secured for execution of tasks. Liaison with external research workers maintained.	Do Shark Bay and Exmouth Gulf survey. Complete analysis of data from previous work. Maintain liaison with external research workers & Aboriginal communities. Continue to act as focus for salvage of specimens.		
Liaison	Represent CALM's interest	9 Marine Conservation research methods J Stoddart		Prepare RPP
	Marine resources	10 Dugong and marine turtle management RS142-145 RIT Prince	Futher field investigations for dugong carried out by Aboriginal community West Kimberley with ANPWS support. Additional personnel involved in marine turtle work with ANPWS support. Further funding applications submitted	Proceed as funding permits

# PLANT DISEASES PROGRAM

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## PROGRAM LEADER

BL Shearer

## CURRENT RESOURCES (1989/90)

This program comprises 15.10 persons (3.30 Professional + 1 Contract Professional + 8.80 Technical + 2 Contract Technical). Its estimated CRF budget is \$538 749 (including \$379 509 salaries and \$159 240 operating costs).

## RESOURCES IN PREVIOUS YEAR

The program comprised 13.20 persons (2.3 Professional + 1 Contract Professional + 8.90 Technical + 1 Contract Technical). Its CRF budget was \$481 247 (including \$321 009 salaries and \$160 238 operating costs). External funds attracted during 1988/89 were \$90 400. These were used to employ the contract staff and provide an operating budget (see Table 3).

## BACKGROUND

The plant diseases program has evolved from studies on the cause of dieback and death of Jarrah first observed in the early 1920's. In addition to the work on death of jarrah, research was undertaken on wood rots in the 1930's. The discovery that *Phytophthora cinnamomi* was associated with jarrah deaths in the late 1960's resulted in considerable research effort on the effect of the jarrah forest environment on increase and spread of *P. cinnamomi* and ways to control the pathogen. Emphasis must now be given to applying this knowledge to the management of the jarrah forest in the presence of the disease.

*Phytophthora cinnamomi* is a destructive pathogen not only in the jarrah forest but has killed native vegetation in woodlands and heaths and is associated with the death of pine in plantations. *Phytophthora* species other than *P. cinnamomi* also threaten plantations and native communities of the South West of the state. As part of the development of management plans and control methods, there is a need for more research on *Phytophthora* species in areas important for conservation. Pathogens other than *Phytophthora* species cannot be ignored. *Armillaria luteobubalina* causes death of a wide range of woody hosts and cankers cause crown

decline in forests, plantations and rural areas. Decay fungi destroy the quality of wood.

In addition to research, the program provides a service for the detection of *Phytophthora* species. The information provided by the service is vital to prevent the spread of *Phytophthora* species during the course of operations. A diagnostic service for nursery diseases is also provided.

By 1993 knowledge gained will be incorporated into hazard, risk and control systems for the protection and management of conservation and production areas in the presence of diseases. Information gained will be used to update a list of plant pathogens present in conservation and production areas and to rank their importance from assessments of their impact on plant health and timber production and quality.

## ACHIEVEMENTS

Highlights of plant disease research extension has been the production of a major review of *Phytophthora cinnamomi* in the jarrah forest and a 9 minute video on south coast dieback.

Systems using presence of indicator plant species have been developed to rate *P. cinnamomi* hazard in the high and the intermediate-low rainfall zones of the northern jarrah forest. The high rainfall zone system has been validated and accurately predicted 80% of the high impact (many jarrah dying or dead) types. The system for the intermediate-low rainfall zone is presently being validated. Under evaluation are potential improvements to the systems by the incorporation of position in the landscape and aspect.

Stress and growth of jarrah on *P. cinnamomi* infected high impact sites and on intermediate/low impact (few if any dead jarrah, few to many dead *Banksia grandis*) sites have been compared during summer droughts. Water stress was greatest in jarrah trees on infected than those on uninfected sites. The level of stress was greater on high than on intermediate/low sites. Overall effects of *P. cinnamomi* on tree growth are complex, being determined by the level of infection of individual trees, the "thinning effect" caused by the fungus killing competing trees on site.

Jarrah resistant to *P. cinnamomi* have been identified. The heritability of the resistant character in the field trial was found to be 0.86. A broader screening program has now commenced to select resistant lines for use in a *P. cinnamomi*-resistant jarrah seed orchard.

Research over the last two years has significantly advanced knowledge of the impact, development and spread of *Phytophthora* species in non-forested areas. The rate of expansion of disease in banksia woodland infected with *P. cinnamomi* has been determined from aerial photographs over a period of 35 years. When not assisted by movement of soil or free water the diseased areas increased by 1.0 m/year. In two banksia woodland communities the fungus was recovered from groundwater 3 m and 5 m below the soil surface.

A major investigation of the impact of *P. cinnamomi* on the vegetation of the Stirling Range National Park commenced in December. Collections have accumulated in excess of 523 plant species representing 432 herbarium vouchers and 466 field vouchers. Of the 281 plant species rated for susceptibility to the fungus, one third were affected by disease and 30% of these were very susceptible. Relationships between community structure and impact of the disease have been determined.

Assessment of chemicals to control *Phytophthora* species is a continuing high priority. One application of metalaxyl significantly reduced recovery of *P. cinnamomi* from colonized pine plugs buried up to 1.3 m in Bassendean Dune sand. Ten per cent phosphorous acid has arrested lesion extension in *B. grandis*.

Isozyme analysis has been used to determine the identity of *Endothia* and *Cryphonectria* species isolated from cankers of jarrah.

Of the 318 cultures that were forwarded by the detection service for the identification of *Phytophthora* species, 59 were identified to species level. A database of distribution and hosts of *Phytophthora* species is being compiled from the sampling data.

## AIM

To diagnose causes of diseases; investigate the conditions that favour the increase and spread of pathogens; determine the effects of diseases on the health, growth and reproduction of plants in native communities, plantations and nurseries and on the

quality of timber; and develop methods for control of diseases.

## PRIMARY OBJECTIVES:

### Diagnosis

To recognize and assess the effects of disease in any situation of concern. To diagnose the causes of diseases or damage in native communities, plantations and nurseries whether they are caused by abiotic factors or infectious agents. To identify pathogens.

### Assessment of Damage

To survey and assess the economic and conservation importance of diseases.

### Disease Dynamics

To understand the effect of environment on host, survival, increase and dispersal of pathogens, the infection of plants and expression of host resistance. To develop risk-rating systems where appropriate.

### Disease Management

To determine the effect of management practices, climate, site, and host susceptibility on consequence of diseases in plant communities, plantations and nurseries. To develop hazard-rating systems where appropriate.

### Control

To develop cost-effective and scientifically sound methods of controlling diseases of woody plants. To advise as to how areas are to be best managed to maintain stable and healthy communities that are not predisposed to disease in the short and long term.

### Communication

To communicate the results of research in the form of publications, educational literature, committee representation, training courses and seminars and to liaise and co-operate with the public, staff of other organizations and CALM personnel.



## 20 YEAR GOALS (based on current resources and in priority order)

1. Develop management plans for the control of *Phytophthora cinnamomi* and other *Phytophthora* species in forests, woodlands and heaths based on knowledge of disease behaviour in response to site, vegetation and climate. \*\*\*
2. Identify and rank diseases present in conservation areas from an assessment of their impact and likely threat to the health of plant communities. \*\*\*
3. Identify and rank diseases of commercial tree species according to likely economic impact on timber production and quality. \*\*\*
4. Develop management plans for the control of important diseases other than *Phytophthora* species based on disease behaviour in response to site, vegetation and climate. \*\*
5. Increase the awareness of departmental staff to symptoms of disease. \*
6. Maintain culture collections and establish a fungal herbarium and a system to ensure that an inventory of diseases woody plants is updated regularly. \*

## 5 YEAR GOALS (in order of priority)

1. Test methods of controlling the spread of *P. cinnamomi* from "spot infections" where large areas of otherwise uninfected vegetation may be at risk.
2. Develop risk-rating systems for *P. cinnamomi* from an understanding of the effects of environment and site on the survival, sporulation and dispersal of the pathogen in native plant communities.
3. Establish a data base of the distribution and importance of *Phytophthora* species and hosts susceptible to these pathogens (jointly with Flora Conservation Program).
4. Develop, apply and test a *P. cinnamomi* hazard rating system for southern forest, woodland and heathland communities. Develop the Shearer *P. cinnamomi* hazard rating system for the northern jarrah forest to incorporate the effects of disturbance and silvicultural practices.

5. Identify communities, particularly those of limited distribution, which are vulnerable to disease (jointly with Flora Conservation Program).
6. Determine the effects of *P. cinnamomi* on growth of jarrah on a range of sites and relate growth efficiency to the amount of infection and damage in root systems. Assess silvicultural methods of enhancing the resistance of jarrah stands infected with *P. cinnamomi* (jointly with Silviculture Program).
7. Select jarrah and pine resistant to *P. cinnamomi* (jointly with Silviculture Program).
8. Determine how *P. cinnamomi* invades *P. radiata* and determine conditions that affect susceptibility and result in tree death.
9. Identify the fungi that cause discoloration and rot in regenerated karri. Assess their economic impact on timber and utilization and, if appropriate, recommend methods to minimize their incidence (jointly with Wood Utilization and Silviculture Programs.)
10. Evaluate the impact of *Armillaria luteobubalina* in karri, jarrah and wandoo communities and elucidate the factors favouring host infection.
11. Establish the importance of canker fungi that damage the crowns and stems of eucalypts and determine the factors favouring host infection.
12. Maintain the culture collection and fungal herbarium and develop a system for an inventory of diseases of woody plants.
13. Determine the incidence and distribution of *Sphaeropsis* and other pathogens of pine and evaluate the damage caused.
14. Evaluate techniques that may aid in the identification of fungi and determine the variability of pathogens (jointly with Flora Conservation Program).
15. Determine whether insect infestation predisposes trees to infection by canker and root rot pathogens (jointly with Entomology Program).

## Diagnostic Services

Members of the Plant Diseases Program are involved in general inquiries relating to diagnosis of diseases for operations and nursery departmental staff. They continue to take responsibility for maintaining the Detection Service. The service is important to the maintenance of a high standard of accuracy in dieback mapping and of hygiene in the departments operations and nurseries.

Soil samples are tested for the presence of *Phytophthora* species. Samples are processed at the Dwellingup Research Centre and *Phytophthora* species identified by Mike Stukely at the Como Research Centre. The wages of a part time assistant are provided from the budget of the Dwellingup Research Centre. Elaine Davison diagnoses diseases and gives advice on problems on nurseries when requested.

## PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)

8,9,10,13,14,16,17,18,22,24,25,26,27,40,42

## PROPOSED NEW PROJECTS - with existing resources (in priority order)

8,38,16,36,24,35,33,43,44

Together with:

- Use phosphorous acid to protect rare flora from *P. cinnamomi* infection.
- Develop a model for *P. cinnamomi* reproduction and growth.
- Implement thinning experiments in high moderate and low rainfall zones (ALCOA FIRS grant).
- Measure extension of *P. cinnamomi* lesions in stem and root bark of trees in thinning trials.
- Measure effects of forest thinning on xylem (as opposed to leaf) water potentials.
- Screen jarrah provenances from R. Mazanec for *P. cinnamomi* resistance.
- Inoculation technique for *A. luteobubalina*.

## PROPOSED NEW PROJECTS - with additional resources (in priority order)

- Full time position on south coast dieback.
- Measure growth, water stress and dieback resistance on bauxite mine pits.
- Model jarrah growth in response to changes to water potential, evaporation potential and disease status.

## PUBLICATIONS\* AND REPORTS 1988/89

\*Bunny, F. and Tippet, J. (1988). Inhibitory effects of *Pinus radiata* and *P. pinaster* resin on growth of four *Phytophthora* species. Australas. J. Plant Pathol. 17: 14-16.

\*Crombie, D.S., Tippet, J.T. and Hill, T.C. (1988). Dawn water potentials and root depth of trees and understorey species in south-western Australia. Aust. J. Bot. 36: 621-631.

\*Crombie, D.S. and Milburn, J.A. (1988). Water relations of rural eucalypt dieback. Aust. J. Bot. 36: 233-237.

Crombie, D.S., Hill, T.C., Davison, E.M., Shearer, B.L., and Stukely, M. (1989). State Report. 8th meeting, Research Working Group 7, 18 pp.

\*Davison, E.M. (1988). Forest decline in central Europe. Aust. For. 51: 39-46.

\*Davison, E.M. (1988). The role of waterlogging and *Phytophthora cinnamomi* in the decline and death of *Eucalyptus marginata* in Western Australia. GeoJournal 17.2: 239-244.

Davison, E.M., and Shearer, B.L. (1989). The importance of *Phytophthora* in indigenous forests in Australia. Workshop on Forest Health in the South Pacific, Forest Research Institute, Rotorua, New Zealand.

Hill, T.C. (1989). Dieback in the Fitzgerald River National Park. Report to the co-ordinators of the Fitzgerald River National Park Management Plan.

Hill, T.C. and Stukely, M. (1989). *Phytophthora* north of Perth. Report to Protection Branch, 4pp.

Hill, T.C. and Tippett, J.T. (1989). The efficacy of metalaxyl and formaldehyde for the eradication of *Phytophthora cinnamomi* from Bassendean sand. Proc. Australas. Plant Pathol. Soc. 7th Conference, Univ. Queensland.

Shearer, B.L. and Hill, T.C. (1988). Diseases threatening declared rarer flora. Proc. Declared Rare Flora Workshop, CALM.

\*Shearer, B.L. and Tippett, J.T. (1988). Distribution and impact of *Armillaria luteobubalina* in the *Eucalyptus marginata* forest of south-western Australia. Aust. J. Bot. 36: 433-445.

Shearer, B.L., Dillon, M.J. and Buehrig, R.M. (1989). Population dynamics of *Phytophthora cinnamomi* in Banksia woodlands and the jarrah forest of south-western Australia. Proc. Australas. Plant Pathol. Soc. 7th Conference, Univ. Queensland.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1987-88	Targets 1988-89
Diagnosis	3,Service	1 Dieback Detection Service (M Stukely)	Identify <u>Phytophthora</u> spp. Develop database	Continue, identify, summarize, publish
	Service	2 Nursery diagnosis (E Davison)	Ongoing service	
	11	3 Cankers in arboretum 73/86 (B Shearer)	Continue survey	Finish survey and analysis
	11	4 Crown decline in tuart 49/87 (B Shearer)	Prepare survey sheets, start	Continue survey
	11,14	5 Identification eucalypt canker fungi 55/88 (E Davison)	Isozyme analysis complete	Write up
	Service	6 Diagnosis as problems arise (All staff)		
Assessment of Damage	3,5	7 <u>P. cinnamomi</u> impact & host range	Data base designed	New Project : Prepare RPP
	6	8 Tree growth, Churchman and Kamet (E Davison)	Jarrah phenology	Write up
		9 14/84 (B Shearer)	25 sites assessed	Complete analysis
		10 50/87 (S Crombie)	50% sampled	Collect final sample & analyse
	6	11 Jarrah deaths 35/84,43/87 (B Shearer)	23 areas & 3 blocks assessed	Enter data in INTERGRAPH & analyse. Relate to climatic data.
		12 Aerial	120 000 ha assessed	
	3	13 Distribution & impact of <u>Phytophthora</u> spp. 23/87 (T Hill)	Ongoing sampling	Prepare for publication
	10	14 <u>Armillaria</u> in wandoo 75/86 (B Shearer)	62 plots assessed and analysed	Write up
	6	15 Growth of jarrah in low & moderate dieback impact sites (S Crombie)	External funds obtained	Instrument and measure
	3,5	16 Impact of <u>P. cinnamomi</u> on vegetation of Stirling Range National Park (R Wills)	Commence survey	Write up

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90
Disease Dynamics	2,3	17 Occurrence & rate of spread of <i>Phytophthora</i> spp in woodland 22/87 (T Hill)	Sample 8 dead or dying Banksias	Prepare for publication
	2	18 <i>P. cinnamomi</i> population dynamics in woodland 76/87,4/87 (B Shearer)	5 sites sampled monthly	Continue sampling for 1. more year, summarize
	2	19 <i>P. cinnamomi</i> dispersal model 74/86,37/87 (A Kennett-Smith)	Simulation model developed	Dispersal experiments, refine model
	2	20 Site hydrology & <i>P. cinnamomi</i> dispersal 23/84 (J Kinal)	Automated piezometers	Continue measurements
	2	21 <i>P. cinnamomi</i> survival & sporulation 6/89 (B Morgan)	External funds obtained. Experiments started	Write up
	8	232 <i>P. cinnamomi</i> & pine 62/86 (M Stukely)	Abandoned	-
	8	23 <i>P. cinnamomi</i> & pine (M Stukely)	Inoculation trials	New Project : Prepare RPP
	Disease Management	4	Northern jarrah <i>P. cinnamomi</i> hazard systems	
		24 System development 40/83 (B Shearer)	System developed & tested in high rainfall zone	Validate changes
		25 Mapping hazard 34/87 (B Shearer)	6 areas mapped	Select 2 more areas for mapping
6,4		<i>P. cinnamomi</i> & site water status		
		26 Vegetation water stress 6/85 (S Crombie)	MS completed	Publish
		27 Hydrological model of Jarrah 52/87 (S Crombie)	Sites selected & instrumented	
		28 Automated measurement of tree water stress & growth 32/87	Sites selected	Instrument & measure
	29 Thinning & water status 51/87 (S Crombie)	4 sites selected	Select more sites & instrument	
7	30 Selection of Jarrah resistant to <i>P. cinnamomi</i> 42/85 (M Stukely)	Monitor field trials completed, analysis in progress	Complete analysis. Prepare for publication	

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-89	Targets 1989-90
	7	31 <u>P. cinnamomi</u> resistant jarrah clones (M Stukely)	Field planting from cloned material	Continue monitoring
	7	32 Test jarrah provenances for resistance (M Stukely)	Inoculate first trial	Analyse & measure
	7	33 <u>Pinus radiata/ P. cinnamomi</u> screening 30/78 (M Stukely)	Inoculate and measure series 13	Inoculate, measure series 14
	4	34 Interaction of <u>P. cinnamomi</u> and logging on Jarrah regeneration (B Shearer)	Sites selected	<i>New Project</i> : Prepare RPP
	4,6	35 Extension of <u>P. cinnamomi</u> and thinning (S Crombie)	External funding obtained	<i>New Project</i> : Prepare RPP
	6	36 Water reation coppice & trees 57/88 (S Crombie)	Measurement completed	Write up
	4,6	37 <u>P. cinnamomi</u> extension and water potential (S Crombie)	External funding obtained	<i>New Project</i> : Prepare RPP
	2,4	38 Canopy density & soil temperature 8/89 (J Kinal)	Select sites & instrument	Monitor and analyse
Control	1	Phosphorus acid 39 Dose response 77/86 (B Shearer)	Optimal dose determined	Determine changes with time
		40 Conservation areas 72/86 (B Shearer)	2 areas treated	Monitor mortalities
	1	41 Eradicants 24/87 (T Hill)	Finish assessing survival	Write up
Communication		42 A video on <u>Armillaria</u>		Film infected areas this winter
		43 Videos on <u>Phytophthora</u> species		Film Cape Arid this summer

# REHABILITATION PROGRAM

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## PROGRAM LEADER

JR Bartle

## CURRENT RESOURCES (1989/90)

This program comprises 15.90 persons (3.35 Professional + 4 Contract Professional + 3.75 Technical + 4.80 Contract Technical). Its estimated CRF budget is \$288 816 (including \$236 851 salaries + \$51 965 operating costs). Additional funds from short term Federal Government grants are estimated at \$596 100. These funds are used to employ the contract staff (\$311 100 salaries) and provide operating expenses (\$285 000).

## RESOURCES IN PREVIOUS YEAR

This program consisted of 15.75 persons (2.95 Professional + 5 Contract Professional + 3 Technical + 4.8 Contract Technical). Its CRF budget was \$243 066 (including \$191 101 salaries + \$51 965 operating budget). The program was also supported by short term (3 years) Federal Government grants enabling the employment of the contract staff (\$251 600 salaries) and operating funds (\$384 500) (see Table 3).

## BACKGROUND

The CALM Rehabilitation Program originated in the mid 1970s with the escalation of bauxite mining in the jarrah forest. Bauxite mining has so many ramifications in jarrah forest land use that research co-ordination across the many interested agencies was imperative. This has been successfully achieved. It is presently under the direction of the Research Steering Committee, and now also encompasses related land and water degradation problems, especially salinity and eutrophication.

Bauxite pit rehabilitation techniques are now well advanced and are being extensively adapted to other types of mining in CALM land. Recently, attention has turned to developing better local planning and integration of practices and to undertaking more detailed long term evaluation of the impact of bauxite mining on the ecology and productivity of the forest.

At about the same time, studies of rehabilitation after mining for heavy mineral sands in the

species-rich heathlands of kwongan between Jurien and Eneabba also commenced. These studies have been extended through development of a monitoring program to areas disturbed by coal exploration around Mt Lesueur.

Concerning salinity and eutrophication, CALM's major involvement has been in the identification of suitable reforestation species, tree establishment techniques for farmland especially salt affected soils, and tree farming systems such as agroforestry. As with bauxite mining, technique development is well enough advanced to be looking at integrated application of the many options. This has been called Integrated Catchment Management, i.e. the integrated use of land management practices which maintain productivity and maintain or improve water quality values. A major study has commenced over 8 000 ha of farmland in the Denmark River Catchment to develop the concept. One important component of integrated management is an economically competitive tree cropping option. Such an option is now being rapidly developed for commercial application. This required increased priority for research into the genetics and silviculture of short-rotation eucalypts (especially *E. globulus*).

Another component of integrated management, the protection of remnant native vegetation on farmland, has also been upgraded in priority. Studies into the dynamics of remnant conservation and various rehabilitation management techniques for this vegetation will be carried out on private land in agricultural areas of less than 900 mm of annual rainfall. This will assist with the current community effort to halt land degradation.

During the term of the plan it is also hoped to redirect some resources from problems of the south west to assess problems in other parts of the State.

## ACHIEVEMENTS

The long involvement in rehabilitation after bauxite mining in the jarrah forest has been substantially concluded with the publication of a major review and with the introduction of comprehensive dieback control procedures to the mining operation.

The Rehabilitation Program has made a large contribution to the emergence of short-rotation eucalypts as a potential farm crop. Such a crop is of

great importance to agriculture, water resources and riverine and wetland conservation throughout the south west. To further enhance the development of the crop a large three year Federal Government grant under the National Afforestation Program has been obtained. This will be a major part of the program's activity for this period. It is clear that farm tree planting will need to integrate with other farming practices and the long period of research into agroforestry undertaken within the Rehabilitation and Silviculture programs will prove especially valuable in helping to achieve this.

Farm tree planting research in dryer areas (less than 600 mm rainfall per year) has been concluded and will be replaced with a project to identify and develop management practices for remnants of native vegetation on farms.

### **AIM**

To develop a sound scientific basis for disturbance management and the regeneration of sustainable ecosystems consistent with the purpose for which the land is to be managed.

### **PRIMARY OBJECTIVES**

#### Technique Development

To develop suitable site preparation, plant selection, revegetation techniques and on-going management practices for the rehabilitation of disturbed land.

#### Integrated Land/Catchment Management

To develop practices for the management and rehabilitation of disturbance which are capable of being integrated into productive and/or sustainable land use systems.

#### Modelling

To develop the capability to model relevant disturbance and rehabilitation processes for some major activities. To apply this to guiding research and to the prediction of impacts over space and time.

#### Monitoring

To investigate at least at reconnaissance level every disturbance process active in CALM lands throughout the State.

### Communication

To communicate research results in the form of technical and scientific publications, educational literature, demonstration, committee representation, advice and liaison with other CALM staff, other departments and agencies and the community at large.

### **20 YEAR GOALS (based on current resources and in priority order)**

1. Establish tree cropping and forest management practices as part of integrated land/catchment management systems which will control the salinity and eutrophication problems in the lower south-west.\*\*\*
2. Oversee the establishment of fully integrated management/rehabilitation practices for all mining and quarrying activities in CALM lands.\*\*
3. Develop an understanding of all disturbance processes active in CALM lands throughout the State. Where appropriate develop management and rehabilitation practices.\*
4. Develop the capability for local and regional scale prediction of relevant biological and land use impacts of major types of disturbance\*

### **5 YEAR GOALS**

1. Refine techniques for the revegetation of disturbed CALM lands, farmland and salt affected soils, including establishment and on-going silviculture.
2. Expand the range of species and improve the genetic potential of planting stock available for revegetation.
3. Establish land capability assessment and growth prediction procedures for tree crops in farmland in the greater than 600 mm rainfall zone of the south-west.
4. Establish experiments from which the conservation and production benefits of fully integrated management after mining, salinization and eutrophication can be evaluated.



5. Develop practices for protection and management of remnants of native vegetation in farmland.
6. Undertake reconnaissance of disturbance in CALM lands throughout the State. Maintain an up-to-date knowledge of rehabilitation practices throughout the State and Australia.
7. Continue experimental work to define parameter inputs for models of disturbance/rehabilitation processes.
8. Continue studies of the biology of native plant species of importance in rehabilitation of CALM lands.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following).**

1,4(most),5(most),6,12(part),13.

**PROPOSED NEW PROJECTS - with existing resources (in priority order)**

Farmland reforestation technique 2,3, genetic improvement 7,8(part), land capability assessment 9, production/conservation benefits 10,12(part),

remnant vegetation management 15, reconnaissance of disturbance/rehabilitation 16.

**PROPOSED NEW PROJECTS - with additional resources (in priority order).**

None formulated.

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Anderson, G.W., Moore, R.W. and Jenkins, P.J. (1988). The integration of pasture, livestock and widely-spaced pine in south-west Western Australia. *Agroforestry Systems* 6: 195-211.

\*Bartle, J.R. and Slessar, G.C. (1988). Mining and Rehabilitation. In: "The Jarrah Forest: a complex Mediterranean Ecosystem. (ed. B. Dell, J.J. Havel & N. Malujczuk). Kluwer, Dordrecht.

\*Ritson, P. and Pettit, N. (1988). Research to improve reforestation techniques for saline groundwater discharge control in water resource catchments in the southwest of Western Australia. Report No. WS 25 WA Water Authority.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
Technique Development	Farmland reforestation techniques (Goal 1)	1 Direct seeding (P Pigott)		
		44/86	Prepared for reporting by P Brown	Publish
		46/86	"	"
		79/86	"	"
		13/87	"	"
		26/87	"	"
		28/87	"	"
		29/87	"	"
		Mullin seeding trial	"	"
		Main Roads Dept Demonstration	"	"
	2 Pulpcropping practices (J Bartle & NAP project)	Prepared preliminary RPPs. Established experiments	Finalize RPPs. Establish further experiments	
	3 <u>E. globulus</u> site assessment yield prediction and growth modelling (G Inions & NAP project)	On-going data collection	Further data collection and processing.	
	Saline seep revegetation techniques (Goal 1)	4 Establishment (P Ritson and N Pettit)		
		49/86	No action	Take growth measurements
		70/86	Reported. Continued measurements	Ongoing measurements
		7/87	"	"
		16/87	"	"
		21/87	"	"
		25/87	"	"
31/87		"	"	
32/87		"	"	
40/87		"	"	
41/87		"	"	
7/88		"	"	
8/88		"	"	
5 Species adaptation (P Ritson & N Pettit)				
49/86	Reported. Continued measurements	Ongoing measurements		
50/86	"	"		
51/86	"	"		
52/86	"	"		
30/87	"	"		
5/88	"	"		
Minesite revegetation technique (Goal 1)	6 Sands mining (A Hopkins)			
	RS35	Supervision	Continue supervision	
Species selection/ Genetic improvement (Goal 2)	7 Rehabilitation species trials (J Bartle)			
	14/76	Prepared MS for growth data	Ongoing data collection Publish some results	

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		12/78	Prepared groundwater data for publication	"
		31/78	Prepared MS for growth data	"
		Pulp species trials (NAP project)	Prepared preliminary RPPs. Established experiments	Finalize RPPs. Establish further experiments
		8 Genetic improvement (T Butcher & R Mazanec)		
		27/80 (globulus)	Finalized data processing	Converted to seed orchards
		6/81 (wandoo)	Monitored	Monitor
		24/82 (wandoo)	Growth measurements	"
		25/82 (wandoo)	No action	"
		38/82 (maculata)	"	"
		40/82 (wandoo)	"	"
		38/83 (resinifera)	"	"
		32/84 (globulus)	Performance evaluation	Ongoing growth measurements
		33/84 (accedens)	No action	No action
		34/84 (camaldulensis)	No action	No action
		4/86 (accedens)	"	"
		5/86 (pilularis)	Growth measurements	Monitor
		53/88 (muellerana)	Monitored	No action
		54/88 (muellerana)		"
		8/87 (saligna)	"	"
		5/87 (sideroxylon)	"	"
		10/88 (microcared)	Mortality count	Monitor
		(globulus)	Establish	Finalize RPP mortality count
		(botryoides)	"	"
		(viminalis)	Prepare to establish	Establish at sites
		(grandis)	"	"
Technique Development/ Modelling	Land capability/ growth prediction (Goal 3)	9 NAP project (J Bartle)	Gathered literature and data	Further data collection and processing
Integrated Land/ Catchment Management	Production and conservation benefits (Goal 4)	10 NAP project (R Silberstein)	Established experimental catchments	Monitor
		11 Tacey project (W Tacey)	Operations specifications prepared and published	Project concluded
		12 Agroforestry (R Moore) 264/52	Trees measured Findings published	Monitor
		264/54	Trees tended and measured Findings published	Monitor tree growth

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		5/81	Trees tended and measurement plots established ( <u>P. radiata</u> & <u>P. pinaster</u> )	Monitor tree growth
		10/81	Height & diameter measured, findings reported.	Monitor tree growth
		43/82	Established measurement plots & borefield	Monitor
		2/87	Monitored growth	Monitor
		264/53	"	Monitor
		264/51	-	Monitor
		NSCP grant (D Bicknell)	Research sites established	Data collection
	Management of remnant native vegetation (Goal 5)	13 Wandoo decline (P Pigott)		
		58/86	Monitoring/completion	Publish (P Brown)
		63/86	Terminated	Publish (P Brown)
		78/86	Monitored	Publish (P Brown)
		15/87	Terminated	Publish (P Brown)
		56/87	Treatment continued	Complete & publish
		14 Grazing exclusion (P Pigott)		
		54/86	Established	Monitor
		15 Selection of remnants for protection (P Pigott)		
		Farm demonstrations	Prepare RPP	Monitor
	Regeneration monitoring	Prepare RPP	Monitor	
Monitoring	Reconnaissance (Goal 6)	16 List of disturbance problems (P Pigott)		New Project : Prepare RPP & commence listings
	Monitoring (Goal 6)	17 Apply monitoring policy (J Bartle)	Discuss with other Programs & Divisions	Contribute to implementation of policy.

# RESEARCH COMPUTING PROGRAM

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## PROGRAM LEADER

M Choo

## CURRENT RESOURCES (1989/90)

This program comprises 3.20 persons (3.10 Professional + 0.10 Technical). Its estimated CRF budget is \$255 264 (including \$108 064 salaries and \$147 200 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program consisted of 3.60 persons (2 Professional + 1.60 Technical). During the period one Technical Officer (P. Walsh) left the Division and the position was converted to a Professional computing/biometrics position. This was subsequently filled by Y. Woods whose former technical position is now vacant. The programs budget in 1988/89 was \$260 079 (including \$111 769 salaries and \$148 310 operating costs).

## BACKGROUND

The advent of sophisticated, relatively cheap processing power has led to its rapid and widespread application by research scientists. Many tasks, including data collection and analysis were previously done manually.

A structured, systematic approach is required to address properly the computing needs of research personnel, thus providing the most efficient use of resources. The Research Computing Program seeks to facilitate that systematic approach in providing support and advice throughout the Research Division.

## ACHIEVEMENTS

The goal of providing at least one personal computer terminal per research scientist was accomplished. Training courses were conducted regularly at Woodvale, Herbarium, Manjimup and Busselton. There has been a considerable increase in the level of computer literacy, expertise and use among Research Division staff.

Within the Division the computing approach and equipment in use have been standardized. Hardware

and software have been integrated and laptop computers are now an integral part of field work.

The NUMTRACK system was transferred from the Tektronix to the VAX.

A video digitizer has been acquired.

## AIM

To set up and maintain an integrated computing environment within the Research Division. To promote the use and understanding of computers amongst personnel and to provide research data to the Department as a whole.

## PRIMARY OBJECTIVES

### Computing Environment

To provide a computing environment for the capture, processing, analysis and dissemination of information.

### Training

To increase computer literacy and expertise among research personnel enabling them to keep abreast of and benefit from the use of new computer technology and software.

### Automation

To maximize the efficiency and productivity of the Research Division by computerizing research tasks and methods currently being performed manually.

### Communication

To communicate and integrate with other groups within CALM and other outside organizations to allow for exchange of ideas, data, software and other products.

## 20 YEAR GOALS

1. Interface with the Department's Geographic Information Systems (GIS) so as to satisfy the mapping requirements of research. Make available and use topo-cadastral information with

standard GIS handling facilities (e.g. digitizing, map production, polygon overlay). Produce high quality output (screen and hardcopy). \*\*\*

2. Provide the mechanisms for integration of the various systems currently used for information management, (e.g. integration of data recording devices with data storage and dissemination devices). \*\*
3. Establish a network of computer communications to provide instant electronic communication with the outside world (i.e. other scientific organizations and databases). \*\*
4. Provide facilities to integrate computers with audio visual data captured via cameras and video recorders and to store and process the data using optical disk technology.\*

#### FIVE YEAR GOALS

1. Provide facilities for rapid processing, storage and analysis of data as well as provide research personnel with state-of-the-art computer based analytical tools and facilities.
2. Integrate Research databases with Geographical Information Systems and provide the information to Researchers on a distributed network basis.
3. Provide and maintain an up-to-date information base to satisfy the information processing and retrieval requirements of the Research Division and the Department.
4. Establish a distributed processing network so that corporate information may be readily accessible throughout the division.
5. Provide facilities and expertise to automate and computerize the functions of statistical analyses, numerical analyses and taxonomy.
6. Achieve a major reduction in the level of mundane manual chores performed by research staff by computerization of most aspects of the researcher's workload, including data collection, analysis and dissemination.
7. Facilitate the transfer of information between mainframe and PC word processors and other forms of document storage for consolidation of papers and other documents.
8. Provide facilities for efficient production of publication quality outputs (reports, graphs, 35mm slides and other illustrations) and integrate these into final publication quality products using desktop publishing facilities.
9. Provide the resources (hardware, software and staff) to raise computer literacy among research staff in computing, statistics and modelling, and promote better understanding of computers among those who have yet to realize their full potential in this area.
10. Extend and enhance training of Research personnel, conduct training workshops on a regular basis and encourage computer based training.
11. Maintain more full time professional computing staff at the major research centres (Woodvale, Herbarium, Como, Manjimup & Dwellingup), thus facilitating the maintenance of a uniform cohesive computing approach within the Division, and helping to identify research requirements, plan, coordinate, develop, install and maintain major systems.
12. Replace or upgrade computer equipment that has become obsolete or no longer satisfies the researcher's processing requirements.
13. Provide electronic mailing facilities to all Research Centres and facilitate electronic transfer of information between the centres. Establish a distributed network to enable communications between the major research centres and the Department's host computers.
14. Extend communications to computers on an inter/intra government basis (eg SNA network) to provide ready access to non sensitive information.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-9	Targets 1989-90	
Computing Environment	Information management & processing	1	Information Base	Information added to following databases: Animal Ecology Biological Survey Fire Ecology Fauna Trapping Flora Conservation Entomology Wetlands & Waterbirds Land management Model Wildflower Returns	Continue to facilitate data updating & provide data management support
		2	Analysis of Data Systems Design	Installation of softwares for statistical & numerical analysis. Systems Design for Herbarium systems: CENSUS & WAHERB.	Continue to provide facilities & train staff to use sophisticated packages. Redevelopment of CENSUS system: migrate WAHERB to a compatible workstation.
		3	Upgrades	Continue with upgrades & reallocation of PCs & softwares.	Use extended memory, link PCs by ETHERNET to other computers within CALM. Upgrade with softwares that support distributed processing.
		4	Obsolescence/ replacement program	Displaywriter obsolete	Replacement of obsolete equipment: UNISON & CPM PCs.
		5	Geographical Information System (GIS)	Further evaluations of ARC/INFO & INTERGRAPH Development of systems	Continue evaluations; GIS packages, PLOTTERIS & digitizers. Selection & development & installation.
				Liaise with LIS group & other GIS users.	
				Organize training sessions at appropriate levels for computing & research staff.	
			Meetings with Research program members to identify GIS reqmts & rationalize on use.	Evaluate corporate data models & investigate ways of facilitating additions to CALM's corporate data.	
Training	Computer Literacy & Expertise within Research	6	Staff training	Courses conducted at Research centres throughout the year.	Basic courses, intermediate & advanced workshops at regular intervals at Woodvale, Herbarium, Manjimup, Dwellingup, Busselton & Como.
		7	Staff support	Regular visits to Research Centres.	Woodvale staff to visit Como & Herbarium on weekly basis, visit other Research Centres at least yearly.
		8	Computing staff	Provide supervision & training of one trainee	Provide professional support & training to computing staff at Manjimup; upgrade skills of staff in the GIS area. Work towards extra staff for Herbarium & Como plus one more to service Research.
Automation & computerization		9	Electronic Field Loggers, Recorders & Laptops	Acquired more Huskey Hunters, NEC & COMPAQ laptop computers. Developed field data acquisition applications.	Continue development of systems, evaluation of other electronic devices for field work. Develop expertise in research staff.
		10	Video Digitizer	Acquired video digitizer	Expand on its use, encourage researchers to use its video capabilities for collecting field data.
		11	Computer Projection panel.	Used extensively in training courses.	Continue usage; encourage researchers to use it for seminars.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1988-9	Targets 1989-90
		12 Systems development	Development & implementation of systems for all areas of research.	Continue developments with emphasis in: - GIS & distributed areas - Herbarium Census - Rare Flora.
		13 Desktop Publishing	Installation at Woodvale & Como.	Installation at Manjimup. Training of key personnel.
		14 Publication quality output	Ventura & Harvard Presentation installed at 2 sites.	Work towards producing PC version of camera images for various research applications. Continue to provide various means for producing professional output for presentations & publications. Investigate possibilities for use with Biogeography Program's bat data identification using calls
		15 Sound recognition devices	-	Investigate hand held computer which provides longitude & latitude by satellite.
		16 Location by satellite	-	
Communication		17 Between Computers	Facilitated connection to PIMS, CALM Vax	Continue liaison with Computer Services & LIS group to maintain links and to work towards integration.
			Upgrade/maintain communications within Woodvale & Manjimup	Extend to Dwellingup & Herbarium. Work at setting up ETHERNET at Woodvale, Herbarium & Manjimup.
		18 Word processor communications	Acquired conversion softwares.	Installation of WORD at all sites; replace existing W/Processors with MS WORD.
		19 Electronic mail	Provided connection to Concurrent NEM. Communicate with other centres via MUX	Extend communications to other areas (Herbarium).



# RESEARCH METHODS PROGRAM

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## PROGRAM LEADER

D Ward

## CURRENT RESOURCES (1989/90)

This program comprises 1.90 Professionals. Its estimated CRF budget is \$92 530 (including \$73 380 salaries and \$19 150 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 2.50 persons (2 Professional + 0.5 Technical). Its budget was \$78 609 (including \$59 459 salaries and \$19 150 operating costs).

## BACKGROUND

The needs in scientific research for experimental and survey design, statistical analysis, and mathematical modelling are so familiar that discussion is superfluous.

## ACHIEVEMENTS

In the past year 40 Research Project Plans have been vetted. Some of these plans extend into the next century. Data sets drawn from fauna conservation, silviculture, hydrology, timber technology, human recreation, biogeography, wetlands, entomology and plant disease have been analysed. New methods such as a Community Attrition Index and a novel approach to measuring the pattern and density of natural entities have been developed.

## AIM

To ensure correct experimental design, data analysis and modelling, and to explore new methods for

converting research information into a form useful for managers.

## PRIMARY OBJECTIVES

### Research design

To help researchers define more clearly the system that they are studying, their aims within that system and how that system relates to other systems.

### Data collection

To help researchers collect data in a way that is amenable to analysis.

### Analysis

To help researchers find the most apt means for identifying patterns and interactions hidden within data.

### Synthesis

To help combine patterns and interactions into models.

## 20 YEAR GOAL

Contribute to the systematic planning and execution of research at all levels from the individual project to the whole program.

## 5 YEAR GOALS

1. Maintain and raise standards of research design.
2. Maintain and raise standards of data analysis.
3. Encourage use of mathematical modelling.
4. Explore and develop new research methods.

Primary Objectives	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
Research design & method development	39/88-65/88 1/89-14/89	All research plans checked, some modified.	Check all submitted plans for sound design.
	Plant diseases Dr E Davison (RPP 40/88)	Designed sampling plan for fungi on nursery seedlings.	Nil
	Biogeography N McKenzie	Developed Community Attrition Index	Written up by D Ward.
	Fire Control Branch D Rawer	Tentative design for Fire Retardant Trial	Carry out trial in field.
Analysis for Other Programs	General Methods D Ward	Progress made toward a general method for assessing density & pattern of organisms in 2 or 3 dimensional space. Field trials made and seminar presented.	Further work.
	Biogeography N McKenzie	Analysis of island plant & animal data.	J Alford to write up.
	G Wardell-Johnson (RPP 1/83)	Analysis of metric data - <u>Geocrinia rosea</u> complex.	G Wardell-Johnson to write up.
	Entomology Dr I Abbott (RPP 32/85, 59/86)	Analysis of data on <u>Tryphocaria</u> in Karri trees.	Dr Abbott to write up.
	Fauna Conserv. K Maisey	Tentative model for Tammar habitat management.	K Maisey to develop further.
	Dr AA Burbidge (RPP 8/86)	Patterns of decline in West Australian mammals.	Written up by McKenzie & Burbidge.
	Dr AH Burbidge (RPP 17,18/86)	Analysis of Ground Parrot habitat.	Dr Burbidge to write up.
	Fire N Burrows (RPP 13/88)	Survey method for wandoo regeneration assessment.	Further development needed.
	Wetlands & Waterbirds Dr S Halse	Analysis of waterbird habitat	Ongoing - Dr S Halse to write up
	Plant Diseases Dr B Shearer (RPP 43/88)	Analysis of pine growth data in relation to slope position.	Dr Davison to write up
	Dr B Shearer (RPP 34/88)	Revision of Dieback Hazard system	Dr Shearer to write up.
	Recreation V Smith	Analysis of recreation survey data from Walpole/Normalup NP	P Albone to write up
	Rehabilitation P Ritson (RPP 8/88)	Analysis of tree survival & growth on saline sites.	P Ritson to write up.
	Silviculture Dr J McGrath (RPP 43/88)	Good progress toward model of pine drought death in Blackwood Valley	Dr J McGrath to write up.
	G Stoneman (RPP 20/85)	Model to predict catchment yield from landform and vegetation.	C Portlock or G Stoneman to write up
P Albone (RPP 15/87)	Wandoo decline analysis.	P Albone to write up.	
Wood Utilization Dr G Siemon (RPP 2/89)	Analysis of sawlog recovery data	Dr Siemon to write up	
Dr G Siemon	Analysis of glue strength for furniture making	P Newby to write up.	

Training: MINTAB microcomputer statistics course given to two Indonesian foresters under regional aid scheme (Co-ordinator Dr F. McKinnell)

BASIC STATISTICS course run over two days for staff at Harvey Wood Utilization Centre.

# SILVICULTURE PROGRAM

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## PROGRAM LEADER

J McGrath

## CURRENT RESOURCES (1989/90)

This program comprises 22.55 persons (4.25 Professional + 18.30 Technical). Its estimated CRF budget is \$902 064 (including \$605 809 salaries + \$296 255 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 23.45 persons (4.45 Professional + 19 Technical). Its budget was \$870 413 (including \$583 158 salaries + \$287 255 operating costs).

## BACKGROUND

The Silviculture Program was formed following the review of all research programs. It reflects the department's objective of efficiently managing the wood production from forests and plantations, while increasing the water catchment, conservation and recreation values of these areas.

The Jarrah forest is arguably the most studied and scientifically the best understood ecosystem in Western Australia. Much is known about the silviculture of Jarrah, particularly factors affecting wood growth, the biology of Jarrah and its role in forest hydrology.

However, there is still much to be learned about this ecosystem which is the most extensive and economically the most important forest in W.A. Responses to silvicultural treatments such as thinning and fertilization are still not fully understood. The morphological and genetic variation of Jarrah over its range awaits definitive study. Knowledge about the other main eucalypt in the forest, Marri, is piecemeal.

In contrast, far less is known about the Karri forest ecosystem. Silvicultural experiments have been confined to high quality pure Karri sites rather than the mixed Jarrah/Marri/Karri forest. A high proportion of clearfelled stands will continue to be artificially regenerated (direct seeding, planting). Seed production areas have been established but research into techniques for maintaining and improving the quality of growing stock is required.

With extension of pine planting to the south coast it will be necessary to determine appropriate silvicultural regimes for this area. Further information on the relationship between stocking and volume production is required in all plantation areas. Greater efficiency of fertilizer use will be achieved by a better understanding of the interactions between site, stocking and responses to fertilization.

Improved varieties of pine are being developed that will increase the productivity of plantations. New technology for seed orchards and cuttings need to be developed to speed the introduction of this improved genetic material to plantations.

By 1993 a better understanding of the environmental and stand factors affecting wood production should be gained. This should enable better silvicultural prescriptions to be formulated.

## ACHIEVEMENTS

In the past year a range of major long term silviculture experiments commenced. In the jarrah forest a family/provenance trial comprising 250 families from 25 populations from the main range of jarrah forest was established in regenerated forest on minesites at Huntly and Jarrahdale. Large scale experiments examining the interaction between thinning and fertilizer were established in both karri forest and radiata pine plantations. These experiments will yield data on the effects of intensive management on the productivity of these systems. It is intended to replicate these experiments on a range of sites.

Experiments on the chemical emasculation of *Pinus radiata* have demonstrated that pollen production can be inhibited. This major advance will allow much greater control of pollination within the new hedged artificially pollinated seed orchard (HAPSO) at Manjimup and thus increase the gains possible from pine breeding. A second generation *P. pinaster* seed orchard was also established at Manjimup during 1988. This will allow the consolidation of gains made by *P. pinaster* breeding research.

A survey of factors affecting the occurrence of drought death in *P. radiata* plantations in the Blackwood Valley was conducted in 1988. The major factors found to influence the occurrence of

drought death are tree stocking, soil depth, landscape position, and aspect. The understanding of the interaction between these factors will allow better prediction of the stocking that different sites can carry. A survey of the factors that contributed to the severe windthrow in the sunkland pine plantations was also carried out.

A major review of research on the interaction between *Phytophthora cinnamomi* and *Pinus radiata* was completed. Resistance to the infection of *P. radiata* by *P. cinnamomi* is under strong genetic control. It appears that the resistance of *P. radiata* to *P. cinnamomi* is controlled by a large number of genes each having a small but additive effect. To minimize productivity losses in plantations it is essential that resistance to *P. cinnamomi* be included as a major character in the genotype of seedlings and cuttings used in afforestation.

A study of the economics of pine agroforestry in the 500-700 mm rainfall zone was carried out in conjunction with Economics Branch using data from long term experiments near Mundaring.

## AIM

To provide the scientific information necessary to optimize economic production of all resources from forests and plantations in the State and ensure that management of timber tree ecosystems has a sound scientific base.

## PRIMARY OBJECTIVES

### Site Classification

To determine how existing stands of timber species and associated tree species differ in their rates of growth, capacity for regeneration and response to disturbance (e.g. disease, insects, drought).

### Stand Management

To determine the optimal silvicultural regimes (establishment, thinning, pruning, fertilization) for forests and plantations managed for timber production. To ensure that these regimes are compatible with other concurrent land use (e.g. water yield, honey production, recreation use).

### Tree Breeding

To optimize wood production, wood quality and disease tolerance of all timber species by the

selection, breeding and production of superior genotypes.

### Communication

To communicate research results in the form of technical and scientific publications, educational literature, committee representation, advice and liaison with other CALM staff, other Departments, and the community at large, and involvement in training courses and public seminars.

## 20 YEAR GOALS

1. Develop silvicultural practices to maximize merchantable volume increment in plantations and forests designated for wood production. \*\*\*
2. Establish plantations and regenerate forests where possible with genotypes which have superior growth rates, form and wood quality and are tolerant of diseases and pests. \*\*\*
3. Manage forests and plantations so as to maximize forest values such as water production and recreation use. \*\*
4. Develop models for forest and plantation protection and production which incorporate the extremes of stand stocking, stand structure, insect and fungal impact, tree form, thinning schedules, nutrition, regeneration strategies water usage, fire regimes, yield of utilizable wood and landscape amenity. \*

## 5 YEAR GOALS

1. Develop a detailed site-vegetation classification of the southern Jarrah forest, suitable for use by forest managers.
2. Determine the key edaphic, climatic and topographic factors that influence the growth of Karri and use this information to develop a model that predicts the productive potential of a site at the commencement of a rotation.
3. Relate climatic and edaphic factors to the survival and growth of pine species in southern W.A.
4. Determine whether substantial genetic variation in growth rates, tree form, resistance to fungal and insect attack exists in Jarrah and use this

variation to select appropriate genotypes for regeneration.

5. Determine the distribution of genetic variability in Karri, including those families in provenance trials, and formulate a strategy for the efficient management of this genetic resource.
6. Investigate the breeding systems of Karri and develop treatments to maximize the production of seed from orchards. The use of vegetative propagation for use in Karri breeding requires evaluation.
7. By the introduction, selection and breeding of *P. radiata* and *P. pinaster* ensure that the genotypes used in pine plantations provide the best possible growth rates, wood quality and disease resistance.
8. Develop seed orchard and vegetative propagation techniques to ensure the supply of improved genotypes for plantation establishment.
9. Determine the effect of stand density and fertilization on the growth rates of Jarrah poles and determine the relationship between stand density and the quantity and quality of water produced from water catchments in the Jarrah forest.
10. Refine chemical methods of non-commercially thinning Jarrah stands.
11. Ensure that new stands develop adequately after logging by optimizing the establishment and fertilization techniques used in the forest.
12. Determine the effect of initial spacing, thinning and fertilizer application on the growth of Karri on a range of different sites.
13. Determine the optimum fertilizer applications for *P. radiata* at all stages of the rotation on the range of soils on which it is grown, and describe the interaction between stocking and fertilization.
14. Determine the relationship between stand density, tree form, tree growth rate and the ability to tolerate drought stress on the range of sites on which *P. radiata* is planted.

15. Quantify the differences in yield of different pine species managed under varying silvicultural regimes and soil types.

16. Optimize the thinning, pruning and fertilization strategies for sawlog and water production from *P. pinaster* stands on the coastal plain.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following).**

1,2,3,6(part: 3/86) 7,9(part: 24/80-43/86) 10(part: 21/77, 3/84) 11(part: 9/82, 19/82, 1/85, 16/85) 12 (part : 8/85, Drought Survey) 13(part : 27/65, 7/66, 12/66) 14(part 1/86) 16(part: 16/58, 20/65, 54/65, 20/68, 16/69) 18(part of RS 28) 19(3/65, 20/72) 20(30/78, 39/83)

**PROPOSED NEW PROJECTS - with existing resources (in priority order)**

Genetic variation in Jarrah : 17; South coast *P. radiata* fertilizer requirements : 12; Jarrah Regeneration techniques : 9; Seed production and cuttings propagation of Karri : 18.

**PROPOSED NEW PROJECTS - with additional resources (in priority order)**

Jarrah stand management : 4(Nitrogen sources), 5(Understocking, competition stand structure); Pine Nutrition 12(Tissue analysis); Jarrah Genetics 17 (Marri provenance trials).

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Hansen, A.P., Stoneman, G.L. and Bell, D.T. (1988). The potential of seeder legumes as a means to increase nitrogen availability in the jarrah forest. Aust. For. 51: 226-231.

\*Schofield, N.J., Stoneman, G.L. and Loh, I.C. (1988). Hydrology of the jarrah forest. In: "The Jarrah Forest". Dell, B., Havel, J.J. and Malajzuk, N. (Eds). Kluwer Academic Publishers: 179-201.

\*Stoneman, G.L., Bradshaw, F.J. and Christensen, P. (1988). Silviculture. In: "The Jarrah Forest". Dell, B., Havel, J.J. and Malajzuk, N. (Eds). Kluwer Academic Publishers: 335-355.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
Site Classification	Jarrah site classification	1. Jarrah site classification project 23/83 (G Strelein)	Published	-
	Karri site classification	2. Karri site classification 19/86 (G Inions)	In press	
		9/88 (P Hewett)	Trial mapping completed. Report prepared.	Complete report
	Pine site classification	3. Drought Survey of Blackwood Valley 43/88 (J McGrath)	Survey conducted	Complete analysis & write report(s)
Stand Management	Jarrah stand management	4. Thinning and Fertilization (S Crombie) 2/88	Water relations measurements continued for the whole year. L.A.I. measurements using digitized photographic images begun on plots.	Continue leaf area and tree water relations measurements. Install automated weather station on site. Automate throughfall and stemflow data collection.
		Compare effectiveness of nitrogen fixation by native legumes with nitrogen fertilization on jarrah growth.	New Project	Prepare RPP
		5. Thinning Responses and Growth Rates (S Crombie) 49/65	No Action (Maintenance)	No Action
		15/66	No Action	No Action
		17/83	Maintenance and remeasurement	Maintenance and evaluate response to fertilizing and re-thinning of plots.
		Determine reasons for understocking and poor stand structure on some sites in NJF	New Project	Prepare RPP
		Determine the effect of stump coppice and advance growth on pole and stand increment and site hydrology.	New project	Prepare RPP
		Assess the relative and total effect of various tree and stand characteristics on the growth rate of jarrah saplings poles and piles.	New project	Prepare RPP
6. Hydrology, water yield and quality (S Crombie) 1/77	Higgins catchment treated. Silvicultural survey of Yarragil 9A catchment.	Monitor all catchments in study.		

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		20/82	Published	-
		16/84	Monitoring continuing	Continue monitoring
		30/85	-	"
		3/86	Study completed (MS prepared)	Publish
		7. Leaf Area Measurement L. E. 704 L. E. 542 (K Whitford)	Developed photographic leaf area measurement technique for field use with Woolongong Uni. Applied technique to thinning experiment.	Refine photographic technique to account for tree stems in the images. Begin use of the photographic technique on catchment scale measurements.
	Jarrah thinning techniques	8. Chemical Thinning of Jarrah (S Crombie) 37/84	Results summarized. Further experiments established	Establish further herbicide experiments
		34/85	"	"
		35/85	"	"
		36/85	"	"
		37/85	"	"
		39/85	"	"
		40/85	"	"
		41/85	"	"
		30/86	"	"
		31/86	"	"
	Jarrah regeneration	9. Regeneration Techniques 24/80 (S Crombie)	Projects on maintenance	Evaluate & decide fate of projects
		18/83	"	"
		19/83	"	"
		20/83	"	"
		23/83	"	"
		12/84	"	"
		13/84	"	"
		6/86	"	"
		43/86	"	"
		Identify and remedy regeneration problems in the northern jarrah forest.	New project	Prepare RPP
	Karri stand management	10. Karri thinning (P Hewett) 3/84	Remeasured. Data analysed	Measure 1990. Publish paper
		25/85	Remeasured. Data analysed	Measure 1990. Publish paper
		3/89	Experiment established & measured.	Fertilizer treatments
		21/77	No further work	Measure early 1990. Reassess manuscript.
		Karri spacing (P Hewett) 25/86	Preliminary data analysis	Finish analysis. Prepare drafts.
		15/82	Measured 88	Data analysis. Prepare drafts.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		Karri establishment (P Hewett) 7/89	Established spot seeding expt. on 2 sites	Measurement analysis + preliminary write-up.
	<u>P. radiata</u> nutrition	11. Nutrition of young <u>P. radiata</u> (J McGrath) 9/82	See 1/85 Growth measurements continued	Evaluate, maybe terminate
		19/82		
		15/83	No Action	Continue measurements
		23/83	See 19/82 [sub experiment of 19/82]	
		1/85	Measurements and sampling continued. Pruned and thinned appropriate treatments	Prepare MSS on phase 1. Insert neturon access tubes.
		16/85	In press	
		17/85	Sampling measurement & nutrient analyses continued	Analyse data.
		33/87	Remeasured	Prepare report
		18/88	80 plots established & fertilized at Albany	Measure annually
		12. Nutrition of older <u>P. radiata</u> and nutrition x fertilizer interactions (J McGrath) 8/85	Progress report prepared. Measurement of 50 plots continued	Continue annual measurements & establish another experiment in this series.
		9/87	Remeasured	Continue measurements
		10/87	Remeasured	Continue measurements & refertilize.
		11/87	Commenced routine monitoring.	Continue sampling & measurement. Replicate on other site types.
		Fertilizer requirements on the south coast	New Project	Prepare RPP
		Tissue analysis in older trees	New project	Prepare RPP
	<u>P. radiata</u> stand management	13. Plantation silviculture (R Moore) 27/65	Trial inspected - low level monitoring	-
		7/66	"	-
		12/66	"	-
		2/82	Trees high pruned	Monitor tree growth
		5/82	Thinning & pruning carried out, height & diameter measured	Monitor tree growth



Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		45/82	Pruning carried out. Height & diameter measured	Continue annual measurements
		3/83	Pruning treatments carried out. Height & diameter measured	Analyse data & write progress report
		6/83	Height & diameter measured	Collate, analyse & report results
		7/83	Height & diameter measured. Progress report written.	Continue monitoring
		28/83	Height & diameter measured	Analyse data & write progress report
		30/83	Height & diameter measured. Estimate thinning volume.	Analyse data & write progress report.
		14/84	Pruned	Monitor
		14 Agroforestry (R Moore)		
		15/73	Trees measured	Monitor tree growth
		10/75	Tree growth measured. Salvaged windthrown trees.	Monitor tree growth
		2/78	Height & diameter measured	Monitor tree growth
		4/80	Tree growth measured	Carry out final pruning. Analyse & write progress report.
		2/86	Trial replanted. Survival assessed	-
	Comparison of species performance	15. Arboreta & species trials (R Moore)		
		25/67	Tree performance monitored	Erect new signs
		26/67	Tree performance monitored	Erect new signs
		27/67	Tree performance monitored	Erect new signs
		44/82	Thinned & pruned	
	<i>P. pinaster</i> stand management	16. <i>P. pinaster</i> silviculture and hydrology (T Butcher)		
		16/58	Study completed	Prepare for publication
		20/65	Study completed	Collate data; plan utilization study
		48/66	Remeasured	Continue annual measurements
		17/67	Heights & diameters measured	Continue annual measurements
		54/66	Study completed	Collate data, plan utilization study

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
		20/86	Study completed	Process data
		16/69	Published	No further action
		29/71	Heights & diameters measured in February 1988	Continue annual measurements
		8/72	Heights & diameters measured	Thinning treatments
		23/73	Heights & diameters measured	Continue annual measurements
		20/75	Heights & diameters measured	Thinning treatments
		20/76	No action	Process data & review
		21/76	Heights & diameters measured	Continue annual measurements
		22/76	Heights & diameters measured	Continue annual measurements
		26/80	No action	Process data and review
		2/81	No action	Process data for publication
		25/83	Put in fertilizer treatments	Monitor
		29/83	No action	Process data
Tree Breeding	Jarrah genetic diversity	17. Genotypic variation in Jarrah (R Mazanec)		
		3/86)	Established family/provenance	Survey survival of trials
		6/87)	Outlier trial	Establish main range provenance trial
		Geographic genetic variation in Jarrah and Marri	New project	Prepare RPP
		Establish Marri provenance trial	New project	Prepare RPP
	Karri genetic diversity	18. Genotypic variation in Karri (D Coates)		
		R.S. 28	Initiate studies of mating systems in karri	Continue monitoring
		26/78 (R Mazanec)	Measured	Measure & index selection
		Seed production	New project	Prepare RPP
		Cuttings propagation of Karri	New project	Prepare RPP

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
	Pine breeding	19. <i>P. pinaster</i> genetics (T Butcher)		
		3/65	Drafts prepared	Finalize publication
		21/65	Assessment, second generation selection	Revise breeding plan
		20/72	Data collated	Prepare for publication
	20.	<i>P. radiata</i> genetics (T Butcher)		
		21/71	Grimwade trial thinned in July 1987	No action.
		22/71	33 ha of progeny tests planted in Kirup and Busselton Districts	Plant major yield trials
		19/72	Grimwade trial measured in February 1987	Analyse results
		29/78	Tree form assessed in January 1987	Analyse results & prepare for joint publications
		30/78	4 glasshouse studies; major review	Screen Adelaide Hills genotypes. Finalize publication
		25/79	Height measurement in January 1987	No action
		21/82	Trees low pruned in July 1987	No action
		39/83	No Action	Evaluate re termination
	Propagation of Pine Genotypes	21. Pine propagation (T Butcher)		
		19/62	3 ha planted at West Manjimup	Complete planting of the 7 ha orchard
		34/68	1.5 ha of HAPSO planted at West Manjimup	Complete planting of the first 8 ha HAPSO unit

# WETLANDS AND WATERBIRDS PROGRAM

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## PROGRAM LEADER

J Lane

## CURRENT RESOURCES (1989/90)

This program comprises 3.20 persons (1.50 Professional + 1.70 Technical). Its estimated CRF budget is \$185 247 (including \$126 307 salaries + \$58 940 operating costs).

## RESOURCES IN PREVIOUS YEAR

This program comprised 3.40 persons (1.70 Professional + 1.70 Technical). Its budget was \$193 844 (\$130 434 salaries + \$63 410 operating costs).

## BACKGROUND

Western Australia has a great diversity of wetland types - greater than that of any other Australian State - ranging from the extensive mangals, tidal mudflats, tropical lakes, rivers and floodplains of the Kimberley region, through the many extensive, occasionally inundated shallow "pans" of the arid north-west and interior, to the highly seasonal, winter-filled lakes and streams of the temperate south-west.

These wetlands support an enormous abundance and substantial diversity of plant and animal life. Many sites are of international significance. Lakes Argyle, Gregory and Roebuck Bay and Eighty Mile Beach each support more than 250 000 waterbirds of 50 or more species, many of them transequatorial migrants. The seasonal swamps of Ellen Brook and Twin Swamps near Bullsbrook contain the only known populations of the endangered Western Swamp Tortoise *Pseudemydura umbrina* one of the rarest animals on earth.

The Wetlands and Waterbirds Program aims to ensure the conservation of these wetlands and their flora and fauna. Central to the program approach is the dual theme of conserving representative samples of wetland types and conserving the systems or networks of wetlands, many of which are seasonal, which are necessary to maintain present numbers of migratory fauna, principally waterbirds.

## ACHIEVEMENTS

Significant accomplishments were:

Publication of "Waterbirds in Nature Reserves of South-Western Australia, 1981-1985" RAOU Report No. 30.

State Government commitment to funding a major new project on waterbird usage of wetlands of the Swan Coastal Plain.

Publication of a major review paper - "Western Australian Wetlands" - concerning the characteristics, conservation and management of the State's wetlands.

Department commitment to funding a three year continuation and expansion of annual waterfowl abundance monitoring in South-Western Australia.

Significant advances in methodology of monitoring and controlling populations of nuisance midges (chironomids) on Perth's wetlands.

Assessment of potential for harvesting of saltwater and freshwater crocodiles (*Crocodylus porosus* and *C. johnstoni*) in Western Australia.

## AIM

To provide scientific information to ensure effective conservation and management of Western Australia's wetland ecosystems, including the maintenance of waterbird populations.

## PRIMARY OBJECTIVES

### Wetland Values

To identify conservation values of the wetlands and wetland systems of Western Australia, particularly with respect to reservation of a representative sample of wetland types, maintenance of species (flora and fauna) diversity and provision of habitat necessary for the maintenance of the State's waterbird populations.

### Status of Waterbird Populations

To monitor and manage the State's 130 species of waterbirds, particularly those species of ducks which are harvested.

### Wetland Ecosystem Dynamics

To develop an increased understanding of the functioning of wetland ecosystems, identify major degrading influences and provide management solutions.

### Public Involvement

To foster a sympathetic public attitude to the conservation of waterbird populations and wetlands through direct involvement of the public in appropriate research projects and through open communication of research findings.

### Communication

To communicate research results in the form of technical and scientific publications, educational literature, committee representation, and to provide advice and liaison with other CALM staff, other Departments, and the community at large by way of training courses and seminars.

### **20 YEAR GOALS (based on current resources and in priority order)**

1. Establish an inventory of wetlands of the State and a reservation system that represents all types of wetlands, with emphasis on improved representation in areas outside the south west and along streams, rivers and tidal zones.\*\*\*
2. Study factors affecting population dynamics, distribution and occurrence of waterbirds, especially game species of duck and migratory waders.\*\*
3. Determine conservation status of wetland and stream invertebrates and native fish and examine factors affecting their occurrence.\*\*
4. Examine the effects of environmental changes on the biota of wetlands and ways of ameliorating the effects of changes including salinization, Greenhouse effect and eutrophication.\*\*

5. Document habitat quality of wetlands, including rivers and streams, with emphasis on riparian vegetation and water quality.\*

6. Study issues related to pest management, artificial creation of wetlands and other management matters to ensure that the actions undertaken are biologically sound.\*

### **5 YEAR GOALS**

1. Establish and maintain a volunteer-based program (500+ observers) for annual assessment of the abundance of waterfowl (particularly game species of ducks) and for identification of important waterbird sites in southwestern Australia.
2. Determine the conservation value (principally the level of usage by waterbirds) of remote wetlands (Lakes Gregory, Argyle, McLeod etc.) of probable international importance.
3. Assess seasonal usage by waterbirds of a number of important, poorly known, wetland sites in south-western Australia.
4. Monitor annually water levels and water quality of a sample of south-west wetlands. Use these data to determine duck shooting seasons and to monitor the condition of wetlands.
5. Analyse results of 1981-1985 RAOU Waterbird Survey project as first step in identifying the general environmental parameters within a wetland that affect its usage by waterbirds.
6. Assess the conservation status of the lentic invertebrate fauna in the south-west through wetland surveys and examine how various environmental parameters (eg. salinity, nutrients) affect the distribution of species.
7. Analyse and publish results of the Fisheries and Wildlife Department duck banding project (funded by ANPWS States Assistance Grant; \$24 000).
8. Assess the conservation values of different habitats in Leschenault Inlet and the effect of mosquito control on those values for waterbirds and invertebrates.

9. Study the effect of salinity on usage of wetlands by ducks for both breeding and as drought-refuges as an indication of the impact of increased salinization in the south-west on waterbirds.
10. Examine food selection in waterbirds in relation to the invertebrate prey available to gain some understanding of how changes in invertebrate species composition that result from salinization affect waterbird distribution.
11. Determine the breeding status (number of breeding colonies, locations and size) of the Great Egret *Egretta alba* in Western Australia.
12. In collaboration with other State and Local Government authorities, develop more effective and environmentally acceptable methods of midge (chironomid) nuisance control.
13. Examine pesticide levels in Herdsman Lake and animals therein in relation to both spraying for Argentine ants and other uses of insecticide within the catchment.
14. Gain a preliminary indication of the level of threat to native avifauna and wetland ecosystems posed by continued use of lead shot for waterfowl hunting in the south-west of W.A.
15. Investigate potential for lowering of salt loads of the Yenyening Lakes system through experimental manipulation of Qualandary Crossing outflows (Yenyening Lakes Interdepartmental Working Group).
16. Preparation of waterbird habitat protection guidelines for Vasse and Wonnerup Estuaries (CALM Vasse-Wonnerup Working Group).
17. Assess the potential for harvest of Kimberley populations of *Crocodylus porosus* and *C. johnstoni*.

**PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994**

(numbers refer to the Table following)

1-4,7,8,9,11-16,18,19,20,21

**PROPOSED NEW PROJECTS - with existing resources (in priority order)**

1. Prepare a State Wetlands Conservation Policy. This is a CALM initiative, in consultation with other relevant authorities and interest groups, commenced in June 1989.

**PROPOSED NEW PROJECTS - with additional resources (in priority order)**

1. State of the Wetlands. Develop procedures for periodic assessment of the rate of loss (or gain) of wetland types. This information would be used to counteract the current piecemeal loss of wetland resources and to enable policy development, protective legislation, acquisition, management etc. to be targetted on areas of greatest need.
2. Crocodile population monitoring. Develop annual monitoring programs for harvested and control (non-harvested) populations of *Crocodylus porosus* and *C. johnstoni* in the Kimberley. Consultants will be used to some extent. Harvesting is planned to commence in 1989 for the Wyndham crocodile farm.

**PUBLICATIONS\* AND REPORTS 1988/89**

\*Halse, S.A. (1988). Variation in the basal body temperature of the common brushtail possum (*Trichosurus vulpecula*) in Tasmania. *Mammalia* 52: 225-231.

\*Halse, S.A. (1989). Wetlands of the Swan Coastal Plain - past and present. In *Proceedings of the Swan Coastal Plain Groundwater Management Conference* (ed. by G. Lowe), pp. 105-112. W.A. Water Resources Council, Perth.

\*Lane, J.A.K., and McComb, A.J. (1988). Western Australian Wetlands. In *The Conservation of Australian Wetlands* (ed. A.J. McComb and P.S. Lake), pp. 127-146. Surrey Beatty & Sons Pty Ltd, NSW, Australia.

\*Lane, J.A.K. (1988). A sight to behold. *Landscape* 4: 39-41.

Lane, J.A.K. (1988). Report on the potential for harvest of wild populations of the freshwater and saltwater crocodiles, *Crocodylus johnstoni* and *C. porosus* in Western Australia. Unpublished CALM report.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-9	Targets 1989-90
Wetland Values	Remote wetlands	1 Kimberley surveys (RAOU, J Lane)	Fitzroy River, lower Ord R. & Lake Argyle surveys	Publish (RAOU)
	Seasonal usage	2 South west surveys (RAOU, J Lane)	Wonnerup, Vasse waterbird populations monitored	Publish (RAOU)
		3 Waterbird use of Wetland Nature Reserves (RAOU, J Lane)	Published (RAOU)	
		4 Waterbird use of wetlands of Swan Coastal Plain (S Halse, RAOU)	Funding commitment obtained from WAWA, EPA & CALM	Select wetlands, recruit observers and begin surveys
		5 Ostracod taxonomy (S Halse)	Descriptions of 1 new genus, 3 new spp prepared for publication, 3 other new species found	Continue surveys & describe new spp as found
	Invertebrate conservation status	6 South-west surveys (S Halse)	Surveys continued	Sample 40 lakes with UWA Honours students, publish results from earlier surveys
Status of Waterbird Populations	Annual abundance	7 November & March counts (S Halse, RAOU, J Lane)	Nov. '88 & March '89 counts conducted	Publish 1988/89 results & make Nov. '89 & March '90 counts.
	Duck banding	8 Analysis of historical data (S Halse)	Paper prepared on annual survival rates	Prepare paper on duck movements for publication.
	Egret colonies	9 Location, size & numbers (RAOU, J Lane)	Colonies monitored	Publish (RAOU)
Wetland Ecosystem Dynamics	Wetland monitoring	10 Sept & Nov surveys (J Lane)	Sept & Nov 1988 surveys undertaken	Do Sept & Nov 1989 surveys
	Environmental parameters	11 RAOU waterbird survey analysis (S Halse, M Williamson)	Analysis of waterbird data completed, paper on breeding seasons in press	Prepare paper on waterbird habitat preferences for publication
	Impact of Mosquito Control	12 Leschenault Inlet (S Halse)	Bird field work continued, preliminary report submitted	Continue bird fieldwork & prepare for publication
	Ducks & salinity	13 Breeding success in SW (S Halse)	Fieldwork at Moora & Wannamal	Limited field work on Perth lake to set out techniques
	Food selection	14 Diet in fresh water (S Halse)	None	Continue project on ad-hoc basis
	Midge nuisance control	15 Midge Research Steering Committee (J Lane)	Control options evaluated	Further testing & evaluation. Publication.
	Herdsmen pesticides	16 Organochlorines in swamphens (S Halse)	Fieldwork & analysis completed	Prepare for publication.
	Wetland Vegetation	17 Longterm monitoring (S Halse)	Paper prepared for publication	None

<b>Primary Objectives</b>	<b>5 Year Goals</b>	<b>Projects (RPP No.)</b>	<b>Tasks completed 1988-9</b>	<b>Targets 1989-90</b>
	Lead shot	18 Gizzard contents analysis (J Lane)	Analysis	Further gizzard & wing collections from less abundant species. Analysis. Publication.
	Yenyening Lakes	19 Experimental flow control (J Lane)	Salinistics, depths & flows (none) monitored.	Final year of monitoring. Preparation of report.
	Vasse-Wonnerup Estuaries	20 Habitat protection guidelines (J Lane)	Funding obtained (Heritage Commission)	Preparation of draft guidelines
	Crocodile harvest	21 Assess potential in WA (J Lane)	Assessment completed. Report prepared	-
		22 Saltwater crocodile populations (RS12-13) (J Lane)	Monitor	Continue



# WOOD UTILIZATION PROGRAM

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## PROGRAM LEADER:

G.R. Siemon

## CURRENT RESOURCES (1989/90)

This program comprises 5.80 persons (3.30 Professional + 1.5 Technical + 1 Contract Technical). Budget is under the control of the Division of Forest Resources.

## RESOURCES IN PREVIOUS YEAR

The program comprised 5.90 persons (3.40 Professional + 1.5 Technical + 1 Contract Technical).

## BACKGROUND

The Wood Utilization Program was formed as a result of the recent program review. The Wood Utilization Research Centre was developed in 1984, with staff from Research Division, Timber Production Branch and Harvey District involved. Input from Research includes the approval of research project plans. However, funding is through Forest Resources Division, with the major funding source being a Public Interest Project from the Commonwealth Government on a \$1 for \$2 basis (equal contributions from the State Government and the timber industry). A Departmental Policy Panel, comprising the Director of Forests, Divisional Manager Forest Resources and Divisional Manager Research (represented by Senior Principal Research Scientist), reviews the research program quarterly.

The Department has an ongoing commitment to wood utilization research.

## ACHIEVEMENTS

Continuing trials of stockpiling jarrah logs under watersprays showed that a regime of 15 minutes on and 165 minutes off did not adversely affect log quality. This is a 92 per cent saving in water and energy required to operate pumps. A trial using low pressure watering systems to stockpile logs was commenced.

Sawmilling trials of regrowth jarrah, karri, marri and Tasmanian blue gum were carried out. All species produced satisfactory sawn recoveries.

Timber drying studies continued, using a research batch kiln and an experimental high temperature kiln.

The major advance was the development of a system to edge-joint and face-joint thin sections of regrowth eucalypts to produce either furniture quality panels or structural material. This has great advantages for the forest products industry and furniture manufacturers.

A study of radiata pine assessed the sawn graded recoveries from logs taken from the green crown of the trees.

Several successful field days at the Wood Utilization Research Centre, Harvey, resulted in research findings being taken up by industry and put into commercial practice. Wood Utilisation staff delivered lectures on wood properties to students in the TAFE Certificate in Timber Technology. Seven WURC Reports were published during the year and six Technical Reports for limited distribution prepared.

## AIM

To provide scientific information to ensure efficient utilization of the timber resources of Western Australia.

## PRIMARY OBJECTIVES

Small eucalypt processing study  
(Public Interest Project)

Sawmilling: To establish techniques for avoiding loss of wood quality and for recovery of maximum volume and value of timber.

Seasoning: To establish techniques for drying timber with a minimum of degrade and develop commercially viable equipment to operate those techniques.

Wood properties: To assess wood properties of regrowth eucalypts.

Product development and marketing: To identify markets and develop processes to achieve added-value in products from regrowth eucalypts.

Use of residues: To improve the use of residues which result from wood processing.

#### Mature hardwood studies

Improve the use of the State's mature hardwood resources.

#### Softwood studies

Improve the use of the State's softwood resources by monitoring of wood quality and by processing studies.

#### Communication

To communicate research results in the form of technical and scientific publications, educational literature, committee representation, and to provide advice and liaison with other CALM staff, other Departments, and the community through training courses, seminars and general extension enquiries.

### **20 YEAR GOALS**

1. Promote the efficient use of the States timber resources, with particular reference to added-value production by integrating utilization and marketing principles.
2. Maintain an ongoing research program to assess new technology and methods in timber processing, in both hardwoods and softwoods.
3. Monitor continuously wood quality in the State's timber resources.

### **5 YEAR GOALS**

1. Develop an objective log grading system.
2. Establish optimum techniques for protecting wood quality in log stockpiles prior to processing.
3. Study techniques of log conversion best suited to converting regrowth eucalypts to high value timber.

4. Develop efficient initial curing schedules and commercial equipment which will allow subsequent defect-free drying to be carried out.

5. Establish efficient schedules and develop commercial equipment for drying timber from regrowth eucalypts.

6. Quantify the physical and mechanical properties of hardwoods and softwoods.

7. Study the wood destroying organisms which are of commercial significance in reducing the value of timber from regrowth eucalypts.

8. Develop a computer model of the forestss products industry to facilitate efficient management of the forest resource.

9. Identify target markets with needs which could be supplied by timber from regrowth eucalypts.

10. Develop processes to meet the needs of target markets in obtaining added-value products.

11. Test the suitability of regrowth eucalypt residues for potential markets.

12. Provide extension and training facilities in timber utilization.

### **PROJECTS TO BE COMPLETED FROM JULY 1989 TO JUNE 1994 (numbers refer to the Table following)**

1,2,3,4,5(part),6(part),7,8,9,10,11.

### **PROPOSED NEW PROJECTS - with existing resources in priority order)**

Nil

### **PUBLICATIONS AND REPORTS (1988-89) (Small Eucalypt Processing Study)**

Brennan, G.K. and Glossop, B.R. (1989). Seasoning 25 mm mature jarrah boards using a progressive tunnel kiln. WURC Technical Report. Limited distribution.

Clark, N.B. (1988). Kraft pulping properties of 17 year old *Eucalyptus marginata* from Western Australia. (CSIRO consultant).

Glossop, B.R. (1989). Assessment of Viva - 20 capacitance type moisture meter. WURC Technical Report. Limited distribution, May 1989.

Hanks, W.R. (1989). Effect of high temperature drying on bow and spring in regrowth jarrah. WURC Technical Report. Limited distribution, May 1989.

Norton, M.P. and Greenhalgh, R. (1989). The assessment of moisture content in timber using ultrasonics (consultants).

White, K.J. (1989). Sawmilling of regrowth karri logs. WURC Technical Report. Limited distribution.

White, K.J. (1989). Sawmilling trial of regrowth marri. WURC Technical Report. Limited distribution, May 1989.

#### OTHER REPORTS

Donnelly, D.J., Mathews, L.R. and Hanks, W.R. High temperature drying of green jarrah blocks prior to charcoal production. WURC Technical Report. Limited distribution, May 1989.

Siemon, G. & Donnelly, D. Graded recoveries of timber milled from radiata pine logs from different thinning treatments. WURC Technical Report. Limited distribution, May 1989.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90			
S.E.P.S. Sawmilling	Protection prior to processing	1 Stockpiling 18/85 (G Brennan)	Trial expanded	Complete report			
		8/86 (G Brennan)	WURC Report No.3	-			
		19/88 (K White)	Study commenced	Prepare report			
	Techniques of conversion 2	Sawmilling	7/86 (G Brennan)	Report prepared	-		
			71/86 (K White)	Report prepared	-		
			18/87 (G Brennan)	Report in preparation	-		
			17/88 (K White)	Data collected	Prepare report		
			4/89 K White	Study commenced	Prepare report		
			Seasoning	Developing efficient drying schedules	3 Seasoning 27/85 (G Brennan)	WURC Internal Report, May '88	-
					28/85 (G Brennan)	Seasoning of karri and marri	Prepare report
9/86 (G Brennan)	Report completed (CSIRO liaison)	Prepare review report of Lyctus					
6/88 (G Brennan)	Research continuing	Prepare report					
		14/88 (B Glossop)	Research continuing after initial study completed	Prepare final report			
Wood Properties	Quantify physical and mechanical properties	4 Strength 26/86 (G Siemon)	Initial tests completed (Curtin Univ. co-operation)	Ongoing - sample for more tests			
		5 Durability 41/86 (G Siemon)	Specimens forwarded to CSIRO	Ongoing			
		6 Wood quality 46/88 (E Davison)	Brown wood in karri	Prepare report			
		14/89 (E Davison)	Commence survey	Prepare report			
		7 Density 6/88 (G Brennan)	Data collection on wood density & moisture contents commenced	Ongoing			
		Product Development	Develop processes for added-value products	8 Product development 26/84 (G Brennan)	WURC Report No. 6	-	
				49/88 (P Newby)	Data collected	Prepare report	
50/88 (P Newby)	Data collected			Prepare report			
51/88 (P Newby)	Data collected			Prepare report			

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1988-89	Targets 1989-90
		62/88 (P Newby)	Defining of 'Valwood'	Prepare report
	Market research	16/88 (P Newby)	Study commenced	Prepare report
Residues	Suitability of regrowth residues for markets	9 45/88 (D Challis)	WURC Report No. 9	-
Mature Hardwoods	Quantify physical properties	10 29/84 (G Brennan)	Drying rates of firewood	-
	Developing efficient drying schedules	2/89 (G Siemon)	WURC Report No. 5	-
Softwoods	Quantify physical properties	11 30/82 (G Siemon)	Study commenced	Prepare report
	Techniques of conversion	42/86 (G Siemon)	Wood density assessment continued	Ongoing sampling from geographic range
		21/88 (A Thomson)	WURC Report No. 8	-
	Develop process for added-value products	15/88 (D Donnelly)	Completed	Publish as WURC Report No. 12
			Study commenced	Prepare report

# Appendix I

## Allocation of Staff to Programs

<i>Abbreviations</i>	<i>DR</i>	<i>Director of Research</i>
	<i>SPRS</i>	<i>Senior Principal Research Scientist</i>
	<i>PRS</i>	<i>Principal Research Scientist</i>
	<i>SRS</i>	<i>Senior Research Scientist</i>
	<i>RS</i>	<i>Research Scientist</i>

N.B. Source of funding is from Consolidated Revenue Funds (CRF) unless otherwise indicated.

### EXECUTIVE AND ADMINISTRATIVE SUPPORT

**Professional Total = 6.55**

A. A. Burbidge (Program Leader)	DR	Woodvale	75%
I. Abbott	PRS	Como	40%
J. Armstrong	SPRS (Curator)	Herbarium	30%
J. Bartle	PRS	Como	30%
N. Burrows	SRS	Como	10%
P. Christensen	SPRS	Como	80%
D. Coates	SRS	Woodvale	10%
J. Friend	SRS	Woodvale	10%
S. Hopper	SPRS	Woodvale	60%
G. Keighery	SRS	Woodvale	10%
J. Lane	PRS	Woodvale	50%
L. McCaw	RS	Manjimup	20%
J. McGrath	SRS	Como	20%
R. Moore	SRS	Busselton	10%
B. Shearer	SRS	Dwellingup	20%
G. Siemon	PRS	Como	20%
A. Start	PRS	Woodvale	50%
J. Stoddart	SRS	Mannion	10%

**Technical & Clerical Total (CRF) = 17.45**

L. Cade		Woodvale	100%
J. Dorlandt		Como	100%
J. Eygenraam (part-time)		Herbarium	100%
			(of 2.5 days/week = 50%)
C. Frost (part-time)		Woodvale	100%
			(of 3 days/week = 60%)
R. Giles		Dwellingup	30%
J. Gilmour		Woodvale	100%
G. Godfrey		Como	100%
V. Hamley		Herbarium	100%
J. Healey		Manjimup	100%
R. Hick		Woodvale	100%
			(of 3 days/week = 60%)
J. Imms		Woodvale	100%
P. Jenkins		Busselton	10%
M. Lewis		Como	100%
D. Munro		Woodvale	10%
G. Pearson		Woodvale	20%
M. Pree		Manjimup	100%
J. Pryde		Woodvale	100%
B. Read		Busselton	10%
J. Rooney		Manjimup	20%
C. Sanders		Wanneroo	10%
J. Scott		Herbarium	100%
R. Sokolowski		Woodvale	10%
S. Suffling		Como	50%
H. Warren		Dwellingup	100%
A. Williams		Woodvale	5%
L. Wong		Como	100%
Vacant		Dwellingup	100%
Vacant		Woodvale	100%

EXTERNALLY FUNDED

D. Burton Como 100%

**BIOGEOGRAPHY**

**Professional Total = 5.80**

G. Keighery (Program Leader)	SRS	Woodvale	70%
A.A. Burbidge	DR	Woodvale	5%
A.H.Burbidge	SRS	Woodvale	80%
N. Gibson	RS	Woodvale	100%
S. Hopper	SPRS	Woodvale	10%
A. Hopkins	SRS	Woodvale	25%
K. Kenneally	Snr Botanist	Herbarium	60%
N. McKenzie	PRS	Woodvale	90%
K. Morris	RS	Woodvale	40%
S. van Leeuwen	RS	Karratha	50%
G. Wardell-Johnson	RS	Manjimup	50%

**Technical Total = 5.35**

J. Alford		Woodvale	80%
T. Annels		Manjimup	50%
B. Bromilow (wages)		Woodvale	40%
A. Brown		Woodvale	25%
P. Fuller		Woodvale	10%
G. Liddelow		Manjimup	50%
M. Lyons		Woodvale	100%
J. Rolfe		Woodvale	80%
C. Vellios		Manjimup	50%
I. Wheeler		Manjimup	50%

**ENTOMOLOGY**

**Professional Total = 1.6**

I. Abbott (Program Leader)	PRS	Como	60%
J. Farr	RS	Manjimup	100%

**Technical Total = 4.3**

T. Burbidge		Como	100%
M. Cully		Como	30%
P. Skinner		Manjimup	100%
P. Van Heurck		Como	100%
Vacant		Manjimup	100%

**FAUNA CONSERVATION**

**Professional Total = 3.95**

J. Friend (Program Leader)	SRS	Woodvale	90%
D. Algar	RS	Woodvale	50%
A.A. Burbidge	DR	Woodvale	5%
A.H. Burbidge	SRS	Woodvale	15%
J. Kinnear	SRS	Woodvale	100%
N. McKenzie	PRS	Woodvale	10%
K. Morris	RS	Woodvale	60%
D. Pearson	RS	Woodvale	10%
R. Prince	SRS	Woodvale	50%
A. Start	PRS	Woodvale	5%

EXTERNALLY FUNDED

D. Algar Woodvale 50%

**Technical Total = 4.85**

B. Bromilow (wages)		Woodvale	60%
P. Fuller		Woodvale	50%
J. Gardner		Woodvale	10%
T. Leftwich		Woodvale	100%
M. Onus		Woodvale	100%
J. Rolfe		Woodvale	20%
N. Thomas		Woodvale	100%
A. Williams		Woodvale	45%

## FIRE

**Professional**      **Total =**                      **5.95**

N. Burrows (Program Leader)	SRS	Como	90%
P. Christensen	SPRS	Manjimup	20%
A.A. Burbidge	DR	Woodvale	10%
G. Friend	SRS	Woodvale	100%
A. Hopkins	SRS	Woodvale	60%
L. McCaw	RS	Manjimup	80%
D. Pearson	RS	Woodvale	90%
A. Start	PRS	Woodvale	45%
S. van Leeuwen	RS	Karratha	50%
G. Wardell-Johnson	RS	Manjimup	50%

**Technical**                      **Total(CRF) =**      **10.25**

T. Annels		Manjimup	50%
P. Fuller		Woodvale	35%
J. Gardner		Woodvale	90%
M. Langley		Woodvale	100%
G. Liddelow		Manjimup	50%
K. Maisey		Woodvale	100%
D. Mitchell		Woodvale	100%
J. Neal		Manjimup	100%
A. Robinson		Manjimup	100%
R. Smith		Manjimup	100%
C. Vellios		Manjimup	50%
B. Ward		Manjimup	100%
I. Wheeler		Manjimup	50%

### EXTERNALLY FUNDED

G. Hall		Woodvale	100% (of 2 days/week = 40%)
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## FLORA CONSERVATION

**Professional**      **Total (CRF) =**      **1.30**

D. Coates (Program Leader)	SRS	Woodvale	85%
S. Hopper	SPRS	Woodvale	10%
G. Keighery	SRS	Woodvale	15%
K. Kenneally	Snr Botanist	Herbarium	5%
T. MacFarlane	Botanist	Herbarium	5%
N. Marchant	Snr Botanist	Herbarium	5%
S. Patrick	Botanist	Herbarium	5%

### EXTERNALLY FUNDED

A. Kelly (part-time)		Woodvale	100% (of 2.5 days/week = 50%)
A. Napier (part-time)		Woodvale	100% (of 2.5 days/week = 50%)
J. Sampson (part-time)		Woodvale	100% (of 2.5 days/week = 50%)
Vacant		Woodvale	100%

**Technical**                      **Total =**                      **1.75**

J. Alford		Woodvale	15%
A. Brown		Woodvale	25%
R. Cranfield		Herbarium	25%
P. Fuller		Woodvale	5%
R. Sokolowski		Woodvale	85%
P. Spencer		Herbarium	20%

## HERBARIUM

**Professional**      **Total (CRF) =**      **10.25**

J. Armstrong	SPRS (Curator)	Herbarium	70%
A.A. Burbidge	DR	Woodvale	5%
A.H. Burbidge	SRS	Woodvale	5%
S. Hopper	SPRS	Woodvale	20%
G. Keighery	SRS	Woodvale	5%
K. Kenneally	Snr Botanist	Herbarium	35%



B. Koch (part-time)	Botanist	Herbarium	100% (of 2.5 days/week = 50%)
N. Lander	Botanist	Herbarium	100%
T. Macfarlane	Botanist	Herbarium	95%
N. Marchant	Snr.Botanist	Herbarium	95%
B. Maslin	Snr.Botanist	Herbarium	100%
S. Patrick	Botanist	Herbarium	95%
G. Perry	Botanist	Herbarium	100%
B. Rye (part-time)	Botanist	Herbarium	100% (of 2.5 days/week = 50%)
J. Wheeler	Botanist	Herbarium	100%
P. Wilson	Snr.Botanist	Herbarium	100%

#### EXTERNALLY FUNDED

R. Cowan (part-time)		Herbarium	100% (of 3 days/week = 60%)
Vacant (part-time)		Herbarium	100% (of 2 days/week = 40%)

#### Technical Total (CRF) = 5.10

J. Alford		Woodvale	5%
A. Brown		Woodvale	50%
R. Cranfield		Herbarium	75%
S. Curry		Herbarium	100%
C. Parker (part-time)		Herbarium	100% (of 2.5 days/week = 50%)
B. Hasson (Gardener - wages)		Herbarium	100%
J. Searle (part-time)		Herbarium	100% (of 2.5 days/week = 50%)
P. Spencer		Herbarium	80%

#### EXTERNALLY FUNDED

D. Corbyn		Herbarium	100%
B. Jones (part-time)		Herbarium	100% (of 2.5 days/week = 50%)

### MARINE CONSERVATION

#### Professional Total = 1.40

J. Stoddart (Program Leader)	SRS	Marmion	90%
R. Prince	SRS	Woodvale	50%

#### Technical Total = 0.50

A. Williams		Woodvale	50%
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### PLANT DISEASES

#### Professional Total (CRF) = 3.30

B. Shearer (Program Leader)	SRS	Dwellingup	80%
E. Davison	SRS	Como	50%
M. Stukely	RS	Como	100%
R. Wills (Temp)	RS	Manjimup	100%
Vacant		Como	100%

#### Technical Total (CRF) = 8.80

R. Buehrig		Dwellingup	100%
C. Crane		Como	100%
M. Cully		Como	30%
M. Dillon		Dwellingup	100%
R. Fairman		Dwellingup	100%
T. Hill		Como	100%
A. Kennett-Smith		Dwellingup	100%
J. Kinal		Dwellingup	100%
F. Tay		Como	50%
J. Webster		Dwellingup	100%

#### EXTERNALLY FUNDED

F. Bunny		Como	100%
B. Morgan		Dwellingup	100%

## REHABILITATION

### Professional Total (CRF) = 3.35

J. Bartle (Program Leader)	PRS	Como	70%
T. Butcher	RS	Como	40%
A. Hopkins	SRS	Woodvale	15%
R. Mazanec	RS	Dwellingup	60%
R. Moore	SRS	Busselton	50%
P. Pigott	RS	Narrogin	100%

### EXTERNALLY FUNDED

D. Bicknell		Esperance	100%
G. Ellis		Manjimup	100%
B. Mattinson		Como	100%
R. Silberstein		Bunbury	100%

### Technical Total (CRF) = 3.75

T. Birmingham		Dwellingup	60%
P. Jenkins		Busselton	45%
M. Mason		Dwellingup	60%
D. McDonald		Narrogin	100%
B. Read		Busselton	30%
C. Sanders		Wanneroo	40%
J. Stritof		Wanneroo	40%

### EXTERNALLY FUNDED

D. Bennett		Bunbury	100%
T. Duncanson		Manjimup	100%
N. Pettit		Collie	100%
D. Vincent		Esperance	100%
Vacant		Bunbury	100%

(of 4 days/week = 80%)

## RESEARCH COMPUTING

### Professional Total = 3.10

M. Choo (Program Leader)		Woodvale	100%
P. Gioia		Woodvale	100%
M. Williams	RS	Como	10%
Y. Woods		Manjimup	100%

### Technical Total = 0.10

K. Whitford		Dwellingup	10%
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## RESEARCH METHODS

### Professional Total = 1.90

D. Ward (Program Leader)	SRS	Como	100%
M. Williams	RS	Como	90%

## SILVICULTURE

### Professional Total = 4.25

J. McGrath (Program Leader)	SRS	Como	80%
T. Butcher	SRS	Como	60%
D. Coates	SRS	Woodvale	5%
S. Crombie	RS	Dwellingup	100%
P. Hewitt	RS	Manjimup	100%
R. Mazanec	RS	Dwellingup	40%
R. Moore	SRS	Busselton	40%

### Technical Total = 18.30

T. Birmingham		Dwellingup	40%
G. Calvert		Wanneroo	100%
G. Chester (temp)		Dwellingup	100%
M. Cully		Como	40%
I. Drumbell		Busselton	100%
I. Freeman		Dwellingup	100%
R. Giles		Dwellingup	70%
B. Hingston		Busselton	100%
P. Jenkins		Busselton	45%

H. Karchevchi (Wages)  
 M. Mason  
 C. Portlock  
 B. Read  
 J. Rooney  
 C. Sanders  
 J. Schuts (Wages)  
 R. Sokolowski  
 J. Stritof  
 S. Suffling  
 C. Ward  
 K. Whitford  
 A. Wills  
 A. Woodward (Wages)  
 Vacant

Busselton 100%  
 Dwellingup 40%  
 Dwellingup 100%  
 Busselton 60%  
 Manjimup 80%  
 Wanneroo 50%  
 Busselton 100%  
 Woodvale 5%  
 Wanneroo 60%  
 Como 50%  
 Manjimup 100%  
 Dwellingup 90%  
 Como 100%  
 Busselton 100%  
 Albany 100%

### WETLANDS AND WATERBIRDS

**Professional Total = 1.5**

J. Lane (Program Leader) PRS  
 S. Halse SRS

Woodvale 50%  
 Woodvale 100%

**Technical Total = 1.7**

D. Munro  
 G. Pearson

Woodvale 90%  
 Woodvale 80%

### WOOD UTILIZATION

**Professional Total = 3.30**

G. Siemon (Program Leader) PRS  
 G. Brennan RS  
 E. Davison SRS  
 B. Glossop RS

Como 80%  
 Harvey 100%  
 Como 50%  
 Harvey 100%

**Technical Total (CRF) = 1.50**

F. Tay  
 Vacant

Como 50%  
 Harvey 100%

### EXTERNALLY FUNDED

W. Hanks

Harvey 100%

## Appendix II

### Current Research Projects

#### Active Research Project Plans (incorporating Research Working Plans and Research Plans)

The Executive and Administrative Support, Research Computing and Research Methods programs are omitted as these do not have research projects.

Until 1 July 1988 the Herbarium came under the control of the Department of Agriculture and did not run on a Research Project Plan system. Research Project Plans for the Herbarium consist of only those initiated in 1988/89 plus a number transferred from the Flora Conservation Program.

The Marine Conservation Program is only in the developmental stages and to date has no approved Research Project Plans.

\* indicates RPP No. not allocated

RPP No	TITLE	PRINCIPAL INVESTIGATOR
<b>BIOGEOGRAPHY</b>		
16	Sampling small ground-dwelling vertebrates	A. H. Burbidge
20	Biogeography patterns vs soil attributes	N. McKenzie
52	Establishment of monitoring program in C.A.L.M.	A. Hopkins
56	Atlas of all Western Australian Proteaceae (except Banksia)	A. Hopkins
59	Report on survey work at Tutanning Nature Reserve	A. Hopkins
60	Report on survey work at Middle Island/Recherche Archipelago	A. Hopkins
60	Report on survey work at Mount Lesueur	A. Hopkins
63	Report on survey work at Two Peoples Bay	A. Hopkins
75	Cooloomia Nature Reserve	A. A. Burbidge <i>et al.</i>
92	Biogeography of the flora of southern Nullarbor	G. Keighery
94	Islands: Lancelin to Dongara	G. J. Keighery
95	Stirling Range and Environs Flora	G. Keighery
99	Ecological Survey of proposed Boonaning Reserve	A. H. Burbidge & G. Keighery
120	Extending the Nullarbor data base: do the patterns change?	N. McKenzie <i>et al.</i>
121	Assemblage changes over 12 months at Cocklebidy	N. McKenzie <i>et al.</i>
121	Lizard litter patch guilds	N. McKenzie
122	Development of a microcomputer entry system for ecological survey data and entry of sections of the E. Goldfields vertebrate data base	N. McKenzie
125	Biological survey of sites on the Mandora palaeoriver and Radi Hills, Great Sandy Desert	N. McKenzie
126	Late Holocene mammal fauna of the Irwin & Camarvon districts, Western Australia	N. McKenzie
127	Fitzgerald River National Park Survey-F.R.N.P.S. Association consultants	N. McKenzie
128	Buccaneer Archipelago	N. McKenzie <i>et al.</i>
129	Automatic bat assemblage sampling	N. McKenzie
132	Biological survey of islands in the north-west	K. Morris
132	Vertebrate Fauna Survey of Dampier Archipelago	K. Morris
132	Vertebrate Fauna of Monte Bello Islands	K. Morris
132	Management Guidelines for Monte Bello Islands	K. Morris
141	Dorre Island and Associated Shark Bay Islands - Ecological Survey	R. Prince
142	Biogeography of Dugong and Seagrasses in northern Western Australia	R. Prince
1/83	Distribution and taxonomic status of the Geocrinia	G. Wardell-Johnson
1/83	Trial mapping of community-types in regenerating Karri forest	G. Wardell-Johnson
44/88	Endemic Forest Eucalypt survey	G. Wardell-Johnson
*	Salisbury Island	A. A. Burbidge <i>et al.</i>
*	Jibberding/White Wells proposed reserve	A. A. Burbidge
*	Acquire computer tape of the RAOU Atlas of Australian Birds data base for Western Australia	A. H. Burbidge (developmental)
*	Bibliography on, and appraisal of, the contemporary status of the vertebrate fauna of the northern Irwin and southern Camarvon districts.	A. H. Burbidge (developmental)
	Consultancy let by	N. McKenzie (developmental)
*	Acquire up-to-date microcomputer software to pre-process (append and edit) and analyse large matrices of ecological survey data. Maintain and develop expertise in the use of these procedures for a wide variety of data types	N. McKenzie (developmental)
*	Cape Arid Survey	A. H. Burbidge <i>et al.</i>
*	Yanchep National Park Survey	A. H. Burbidge
*	Walpole-Nornalup National Park survey	G. Wardell-Johnson

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
*	Searching versus Pitfall Trapping in Southern Forests Surveys	G.Wardell-Johnson
*	Bird census results in Southern Forests Surveys	G.Wardell-Johnson
*	Rainforest Survey	N.McKenzie <i>et al.</i>
*	Buccaneer Archipel. Management Plan	R.Prince
*	Bat assemblage structure studies disturbance and determinism	N.McKenzie
*	Vegetation of Dryandra State Forest	
	(consultancy let by)	
*	Recherche Monitoring Sites	G.Keighery
*	Interactions of Fire and Site on Vegetation in the Walpole-Nornalup National Park	A.Hopkins
*	Bird communities of the Walpole-Nornalup National Park	G.Wardell-Johnson
*	Assessment of effect of mining exploration on D'Entrecasteaux NP	G.Wardell-Johnson
*	Conservation status & biology of granite rock endemics of the Wheatbelt	N. Gibson
*	Conservation status & biology of granit rock endemics of the karri forest	S.D. Hopper
*	Conservation of the status and biology of granite rock endemics of the pastoral region.	S.D. Hoper
*	Conservation of the status and biology of granite rock endemics of the south coast	S.D. Hopper

## ENTOMOLOGY

20/84	Leaf Dymanics of Jarrah in relation to impact of Jarrah Leafminer.	I. Abbott
27/84	Effect of Jarrah Leafminer on growth of Jarrah incipient ground coppice after fire.	I. Abbott
2/85	Comparison of insect damage to Jarrah ground coppice in the southern and northern Jarrah forests.	I. Abbott
23/85	The annual cycle of abundance and composition of the insect fauna of the southern Jarrah forest canopy, with special reference to <u>Uraba lugens</u> .	I. Abbott
32/85	External symptoms of infestation of Karri by the borer <u>Tryphocaria acanthocera</u> .	I. Abbott
24/86	The impact of repeated defoliations on the wood growth of Jarrah saplings.	I. Abbott
59/86	Survey of the incidence of infestation of the borer <u>Tryphocaria acanthocera</u> in even - aged Karri.	I. Abbott
61/86	Crown deterioration of Jarrah poles in the southern Jarrah forest following grazing of leaves by insects.	I. Abbott
19/87	Effect of fire on Gumleaf Skeletonizer, Jarrah Leafminer and other invertebrates of Jarrah crowns in the southern Jarrah forest.	I. Abbott
44/87	Damage to Jarrah foliage caused by Jarrah Leafminer in Collie District.	I. Abbott
45/87	Crown condition and wood growth of codominant/subdominant Jarrah poles resistant and susceptible to Jarrah Leafminer infestation in Collie District.	I. Abbott
47/87	Survey of Jarrah Leafminer in Jarrah forest between Collie and Dwellingup.	I. Abbott
48/87	Survey of Gumleaf Skeletonizer in Jarrah forest between the currently infested zone and Greenbushes, Mayanup and Nannup.	I. Abbott
20/88	Operational scale testing of the effectiveness of a single Autumn fire in controlling jarrah leafminer.	I. Abbott
39/88	Survival of <u>Uraba lugens</u> on W.A. eucalypts	J. Farr
41/88	Fecundity of <u>Uraba lugens</u> in relation to pupal mass.	J. Farr
42/88	Spatial distribution of <u>Uraba lugens</u> pupae in relation to its jarra host.	J. Farr

## FAUNA CONSERVATION

7/86	Western desert mammal conservation studies	D.J.Pearson
7/86	Search for mainland populations of Shark Bay mouse, <u>Pseudomys praeconis</u>	K.D.Morris
8/86	Patterns of decline in the Western Australian mammal fauna	A.A.Burbidge <i>et al.</i>
9/86	Western Swamp Tortoise: population monitoring	A.A.Burbidge
10/86	Western Swamp Tortoise - captive breeding	A.A.Burbidge
11/86	Breeding seabirds data base	A.A.Burbidge
12/86	Island fauna data base	A.A.Burbidge
16-17/86	Sampling small ground dwelling vertebrates	A.H.Burbidge
17-18/86	Conservation of the Ground Parrot in Western Australia	A.H.Burbidge
39-41/86	Numbat study: habitat and food sources	J.A.Friend
42-43/86	Numbat study: translocation and re-establishment	J.A.Friend
43-44/86	Ecology of the Western Barred Bandicoot	J.A.Friend
44/86	Taxonomy & zoogeography of Australian landhoppers	J.A.Friend
102-103/86	Woylie conservation studies	J.E.Kinnear
104/86	Rockwallaby conservation - wheatbelt & other areas	J.E.Kinnear
105-106/86	Ecology of Predation by the Fox	J.E.Kinnear
106-8/86	Rockwallaby conservation - Dampier Archipelago	J.E.Kinnear
108-9/86	Rockwallaby conservation - Eastern Pilbara	J.E.Kinnear
111/86	Optimization of fox control in W.A. - fox biology and control	D.Algar
130/86	Chiropteran Studies: <u>Mormopterus</u> taxonomy	N.McKenzie
132/86	Mammals of Pilbara Islands - <u>Leggadina lakedownensis</u>	K.D.Morris
147-149/86	Conservation of the Chuditch	K.D. Morris
*	Kangaroo management program (Wildlife Management Policy No. 3)	R.I.T Prince <i>et al.</i>
*	Conservation of the Hooded Plover in Western Australia	A.H.Burbidge
*	Feral animal control - N.W. Islands	K.D. Morris

## FIRE PROGRAM

28/78	Forest fire behaviour under dry fuel conditions (Jarrah)	N. Burrows.
6/84	Does hollow availability limit Mardos in karri.	G.Wardell-Johnson
7/84	Regeneration of heartleaf thickets	G.Wardell-Johnson
8/84	Fire, season and termite activity.	G.Wardell-Johnson

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
15/85	Fire damage to regenerated Karri stands	L. McCaw
21/85	Prescribed fire behaviour in regenerated Karri stands.	L. McCaw
12/86	Effects of five fire regimes on forest understorey species.	N. Burrows
14/86	The development of spot fires in the forest.	N. Burrows
15/86	A computer - based wildfire information storage and retrieval system.	N. Burrows
17/86	Fire behaviour and Fuel accumulation rate and structure in <u>Banksia</u> low woodlands.	N. Burrows <i>et al.</i>
18/86	The combustion rate of forest fuels.	N. Burrows
22/86	Karri forest bird community study.	G. Wardell-Johnson
47/86	Fuel studies in southern wetlands.	N. Burrows
34-36	Effects of prescribed burns on fauna in wheatbelt nature reserves.	G. Friend
36-37	Effects of three fire regimes on ground-dwelling invertebrates.	G. Friend
59-62	Computerized fire management system - Tutanning Nature Reserves.	A. Hopkins
60	Fire effects studies on vegetation, Encabba and Mt Lesuer.	A. Hopkins
60-61	Fire effects studies on vegetation, Recherche Archipelago.	A. Hopkins
62-63	Fire effects studies on vegetation, Tutanning Nature Reserves.	A. Hopkins
63	Fire effects studies on vegetation, Two peoples Bay Nature Reserve.	A. Hopkins
15/87	Effects of various fire control strategies in heathland and shrubland vegetation.	L. McCaw
23/87	The effect of fire on <u>Lambertia raniflora</u>	N. Burrows
42/87	Fire behaviour studies in hummock grasslands.	N. Burrows
46/87	The formation of hollows in karri and marri trees.	G. Wardell-Johnson
13/88	Fire and regeneration of <u>Eucalyptus wandoo</u>	N. Burrows
20/88	Effects of mosaic burns on birds in hummock grasslands	A.A. Burbidge
22/88	Fire behaviour in heathlands and shrublands.	L. McCaw
23/88	Describing fuel structure and biomass in hummock grasslands.	N. Burrows
24/88	Analysis of historical weather data at Giles to ascertain fire seasons and wind patterns in hummock grasslands.	N. Burrows
25/88	Aerial burning techniques for hummock grasslands.	N. Burrows
26/88	Thematic mapping of fire patterns in hummock grasslands.	N. Burrows
27/88	Analysis of wildfire threat in Jarrah forest.	N. Burrows
29/88	Assessing the effectiveness of grazing in fuel reduced buffers in pine plantations.	N. Burrows
30/88	Effects of fire on heathland and shrubland vegetation of the Stirling Range National Park.	A. Hopkins
31/88	Effects of fire on reptiles, frogs and small mammals in the Stirling Range National Park.	G. Friend
32/88	Effects of season of burn and fire size on desert vertebrates.	D. Pearson
33/88	Effects of patch burning on lizards in hummock grasslands.	D. Pearson
35/88	Appraisal of thematic mapping for mapping hummock grassland vegetation.	D. Pearson
36/88	Computerized fire management system - forest regions.	J. Beck (Protection Branch)
37/88	Aboriginal knowledge of fire management on hummock grasslands.	D. Pearson
38/88	Effects of fire on medium - sized desert mammals.	P. Christensen
11/88	An age series of floristics in a single community type	G. Wardell-Johnson
1/89	Regeneration strategies of vascular plants of the Walpole-Nornalup National Park (a flowering calendar for the Walpole-Nornalup National Park)	G. Wardell-Johnson
11/89	The response of terrestrial vertebrate fauna to disturbance in karri forest.	G. Wardell-Johnson

## FLORA CONSERVATION

25	Conservation genetics of rare flora.	D.J Coates
26	Genetic systems of rare flora.	D.J Coates
26	Life history and eco-geographic studies of rare flora.	D.J Coates <i>et al.</i>
27	Germ plasm storage program for rare and endangered and rapidly declining flora.	D.J Coates <i>et al.</i>
28	Determination of the hybrid status of some rare flora.	D.J Coates <i>et al.</i>
29	Conservation status and genetic variability in six commercially exploited, geographically restricted and dieback susceptible species.	D.J Coates
30	Conservation status and genetic variability in four dominant but rapidly declining species.	D.J Coates
30	Phylogenetic and breeding system studies in the genus <u>Eremaea</u> (Myrtaceae).	D.J Coates
31	Hybridization and gene exchange in a <u>Stylidium</u> contact zone.	D.J. Coates
66	Additions and deletions to the declared endangered flora.	S.D Hopper <i>et al.</i>
68	Presumed extinct and very rare wheatbelt plants.	S.D Hopper
69	Data base on rare and geographically restricted plants of Western Australia.	S.D Hopper <i>et al.</i>
70	Licensing and management of the wildflower industry.	S.D Hopper <i>et al.</i>
71	Reservation status of commercially exploited taxa.	S.D Hopper
72	Conservation of two kangaroo paw species.	S.D Hopper
72	M.App.Sci students Curtin University, Supervisors and Harvesting techniques used in the wildflower trade.	S.D Hopper
73	Review of rare flora conservation in Western Australia.	S.D Hopper <i>et al.</i>
74	Flora poster, leaflets, magazine articles and public lectures.	S.D Hopper <i>et al.</i>
76	Atlas of Western Australia flora pilot project (orchids).	S.D Hopper
77	Native trees and tall shrubs of Perth - guide and atlas	R.J. Powell/ S.D Hopper
78	Orchids of metropolitan Perth.	A.P. Brown/ S.D Hopper
82	Bird pollination, nectar flow and the mating system of <u>Eucalyptus caesia</u> .	S.D Hopper <i>et al.</i>
83	Conservation status, morphometrics and allozyme variation on <u>Eucalyptus marcrocarpa</u> and allied species.	S.D Hopper.
87	A guide to the Eucalypts of the Stirling Range.	S.D Hopper <i>et al.</i>
87	<u>Eucalyptus camabyi</u> - rare hybrid or relict species?	S.D Hopper

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
90	Pollination biology of the Australian flora.	S.D Hopper
95	Conservation, ecology and biology of Western Australia Tremandraceae.	G.J Keighery
96	Garden escapes, naturalized flora of Western Australia.	G.J Keighery
97	Systematics of Western Australia flora.	G.J Keighery
97	Biology of Western Australia plants.	G.J Keighery
*	Undertake field surveys of poorly known high priority species at risk.	D.J. Coates <i>et al.</i>
*	Endangered Flora Wildlife Management Plan for <u>Acacia anomala</u> .	D.J. Coates
*	Endangered Flora Wildlife Management Plan for <u>Drakaea jeanensis</u> .	S.D. Hopper
*	Endangered Flora Wildlife Management Plan for <u>Banksia cuneata</u> .	D.J. Coates
*	Endangered Flora Management Plan for <u>Stylidium corniforme</u> .	D.J. Coates
*	Endangered Flora Management Plan for Northern Forest Region.	
	Consultant botanists	S.D Hopper
*	Reproductive biology and management of <u>Eucalyptus rhodantha</u> .	S.D Hopper
	J. Sampson, S.H James (U.W.A.),	
*	Eucalyptus of Western Australia salt lakes including the new series <u>Rigentes</u> with three new species.	S.D Hopper
	M.I.H Brooker (CSIRO, Forest Research ),	
*	Systematics of the genus, <u>Stylidium</u> .	S.D Hopper
*	Atlas of rare and endangered W.A eucalyptus.	D.J Coates
*	Wildflower Industry Wildlife Management Plan <u>Anigozanthus pulcherrimus</u> and <u>Macropidia fuliginosa</u> .	S.D Hopper <i>et al.</i>
*	Review the distribution and commercial utilisation of <u>Boronia</u> species and develop a Wildflower Industry Management Plan.	S.D Hopper <i>et al.</i>
*	Carry out an annual review of ANPWS statistics on Western Australia's cut flower trade.	D.J. Coates
*	Orchids Pollination Book.	S.D Hopper <i>et al.</i>
*	Orchids of Kalbarri, Leeuwin- Naturaliste, Walpole-Nornalup, Fitzgerald River and Cape Le Grand National Park.	S.D Hopper <i>et al.</i>
*	Book on rare and endangered W. A. flora.	S.D. Hopper
*	Garden escapes, naturalised flora of Western Australia.	S. Patrick
*	Control and organisation of District Reference Field Herbaria & Regional Herbarium.	S. Patrick
*	Isolation of records from incoming material for	S. Patrick &
	1) Additions and deletions to the declared endangered flora	R.J. Cranfield
	2) Presumed extinct and very rare wheatbelt plants	
	3) Database on rare and geographically restricted plants of W.A.	
*	Co-ordination of Herbarium contribution to field surveys of Declared and Rserve taxa.	N. Marchant <i>et al.</i>

## HERBARIUM

8	Revision and conservation status of <u>Beaufortia</u> and <u>Regelia</u> .	A.A. Burbidge
18	Biogeography and taxonomy of creeping triggerplants (Stylidiaceae)	A.H. Burbidge
32	Establishment of field herbaria in all regional and district offices and ranger stations.	R.E.S. Sokolowski
78	A revision of <u>Caladenia</u> , <u>Drakaea</u> and allied genera of orchidaceae in Western Australia.	S.D. Hopper
79	Generic relationships and evolution of <u>Caladenia</u> , <u>Chloraea</u> and allied orchids.	S.D. Hopper
80	A revision of <u>Eucalyptus wandoo</u> and allied species ( <u>Eucalyptus</u> series <u>Levispermae</u> ). M.I.H. Brooker (CSIRO, Forest Research).	S.D. Hopper
81	Twenty new <u>Eucalyptus</u> from Western Australia. M.I.H. Brooker (CSIRO, Forest Research).	S.D. Hopper
81	Taxonomy of new Western Australian <u>Eucalyptus</u> . M.I.H. Brooker (CSIRO, Forest Research).	S.D. Hopper
88	Eucalypts of the Great Victoria Desert	S.D. Hopper
*	New taxa of <u>Drosera</u> (Droseraceae).	N.G. Marchant
*	Infrageneric classification of <u>Drosera</u> (Droseraceae).	N.G. Marchant & D.W. Goodall
*	Taxonomic revision of <u>Actinodium</u> (Myrtaceae).	N.G. Marchant & G.J. Keighery
*	Taxonomic revision of <u>Agonis</u> (Myrtaceae).	N.G. Marchant
*	Taxonomic revision of <u>Chamelaucium</u> (Myrtaceae).	N.G. Marchant & G.J. Keighery
*	New taxa of <u>Darwinia</u> (Myrtaceae); Taxonomy and conservation status.	N.G. Marchant & G.J. Keighery
*	Taxonomic revision of <u>Pileanthus</u> (Myrtaceae).	N.G. Marchant & G.J. Keighery
	Revisionary studies in <u>Xyris</u> (Xyridaceae).	N.G. Marchant
*	Revision of the 'Flora of the Perth Region'.	N.G. Marchant <i>et al.</i>
*	Checklist of obscure plant collecting localities.	N.G. Marchant
*	W.A. botanists, checklist of names and collecting localities.	N.G. Marchant
*	Taxonomic studies in Thymelaeaceae.	B.L. Rye
*	Revision of <u>Hibbertia</u> Subsection Tomentosae.	J.R. Wheeler
*	Taxonomic studies of south western species of <u>Hibbertia</u> .	J.R. Wheeler
*	Flora of the Kimberley Region.	J.R. Wheeler <i>et al.</i>

## MARINE CONSERVATION

133/86	Conservation of Western Australian marine turtles	R.I.T. Prince <i>et al.</i>
142-144/86	Dugong conservation - northern Western Australia	R.I.T. Prince <i>et al.</i>
142-145/86	Management of Dugong & marine turtle exploitation in northern Western Australia	R.I.T. Prince <i>et al.</i>

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
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## PLANT DISEASES

34/83	Long term monitoring of impact of <u>P.c.</u> (Lang and Balmoral Blocks).	B. Shearer
40/83	Prediction of impact of <u>P. cinnamomi</u> from site indication,	B. Shearer
14/84	Assessment of dieback damage to jarrah roots.	B. Shearer
23/84	Effect of high and moderate dieback on hillslope hydrology.	B. Shearer
25/84	Long term dieback monitoring in a high/moderate impact site 10B.	B. Shearer
06/85	Susceptibility of jarrah to rapid summer invasion by <u>P.c.</u>	J. Tippett
07/85	Effect of thinning on growth/cambial activity of jarrah.	J. Tippett
09/85	Long term monitoring of a concave area near Deer Road.	B. Shearer
26/85	Relationship between surface indicators characteristics of the soil profile.	B. Shearer
42/85	Resistance of <u>E. marginata</u> to <u>P. cinnamomi</u>	M. Stukely
55/86	Rate of bark turnover in two eucalypts.	J. Tippett
64/86	An hydraulic model of root, stem, branch and leaf tissue of jarrah.	S. Crombie
65/86	Water relations of jarrah dieback.	S. Crombie
66/86	Effect of rainfall on established <u>P.c.</u> lesions in jarrah.	J. Tippett
72/86	Injection of healthy <u>Banksia seminuda</u> with fungicide, (Forestyl-Al).	B. Shearer
73/86	The association of pathogens with mortality of <u>Eucalyptus</u> species.	B. Shearer
74/86	Simulation of water movement in the upslope areas of the Northern Jarrah Forest.	A. Kennett-Smith
75/86	The impact of <u>A. luteobubalina</u> in the Wandoo forest.	B. Shearer
76/86	Population dynamics of <u>P. c.</u> in jarrah/banksia.	B. Shearer
77/86	The effect of phosphorus acid on lesion development of <u>P.c.</u>	B. Shearer
04/87	Comparison of the rate of spread of dieback in jarrah/banksia.	B. Shearer
22/87	Pattern of invasion and survival of <u>P.c.</u> in <u>Banksia attenuata</u> .	T. Hill
23/87	Distribution of <u>Phytophthora</u> species north of Perth, their impact.	T. Hill
24/87	Treatment of isolated outbreaks of <u>P.c.</u>	T. Hill
34/87	Validation of the <u>P.c.</u> hazard rating system.	B. Shearer
35/87	Phenology of <u>P.c.</u> hazard rating indicators.	B. Shearer
36/87	Hydrology of <u>P.c.</u> hazard rating types: Myara block.	B. Shearer
37/87	Simulation of the hydrology of coastal heathland sandy soils in relation.	B. Shearer
43/87	Quantification of jarrah deaths with time using 70 or 230mm aerial photography.	B. Shearer
49/87	An investigation of the cause of death and decline of tuart.	B. Shearer
50/87	Frequency of barrier zones in xylem of jarrah on dieback sites.	S. Crombie
51/87	Water status of jarrah on thinned and unthinned sites in the Northern Jarrah Forest.	S. Crombie
52/87	An hydraulic model of root stem, branch and leaf tissue of jarrah.	S. Crombie
53/87	Measuring transpiration in jarrah using the automatic heat pulse.	S. Crombie
55/88	Identification of <u>Eucalypt</u> canker fungi	E. Davison
56/88	Water relations and growth of jarrah in high, medium and low impact	S. Crombie
57/88	Water relations of jarrah coppice and trees	S. Crombie
6/89	Zoospore ? at different matric potentials	B. Moran
8/89	Canopy density, soil temperature and <u>P. cinnamomi</u>	J. Kiral
*	Field trials <u>P. cinnamomi</u> resistant jarrah	M. Stukely
*	Screening jarrah provenances for <u>P. cinnamomi</u> existence	M. Stukely
*	<u>P. radiata</u> /Phytophthora inoculation trials	M. Stukely
*	Jarrah growth Churchmans, Kenet	E. Davison

## REHABILITATION

14/76	Rehabilitation species trial.	JR Bartle
12/78	"	"
31/78	"	"
27/80	<u>E. globulus</u> provenance trial	T. Butcher
4/81	1981 Agroforestry trial - Wellington catchment.	R. Moore
6/81	<u>E. wandoo</u> progeny trial.	R. Mazanec/ T. Butcher
10/81	Agroforestry species trial (Vasse 2).	R. Moore
04/82	<u>E. wandoo</u> provenance/family trial on bauxite pit site at Jarrahdale.	R. Mazanec/ T. Butcher
25/82	<u>E. wandoo</u> provenance/family trial on Wellington catchment (Souths Farm).	R. Mazanec/ T. Butcher
38/82	<u>E. maculata</u> provenance trials.	R. Mazanec
40/82	Geographic variation in <u>E. wandoo</u> .	R. Mazanec/ T. Butcher
43/82	Esperance Agroforestry trial.	R. Moore
9/83	Mulching Trial (Flynn's).	R. Moore
38/83	<u>E. resinifera</u> provenance trial.	R. Mazanec
32/84	<u>E. globulus</u> family/provenance trial.	R. Mazanec
33/84	<u>E. accedens</u> family/provenance trial.	R. Mazanec
34/84	<u>E. camaldulensis</u> provenance trial	
5/85	<u>E. wandoo</u> gene pool.	R. Mazanec/ T. Butcher
4/86	<u>E. accedens</u> family/provenance trial.	R. Mazanec
5/86	<u>E. pilularis</u> family/provenance trial.	R. Mazanec
44/86	Broadscale direct seeding techniques to establish native trees and shrubs on established farmland in the Wheatbelt.	P. Brown
46/86	Comparison of insects and vertebrates as removers of tree seed on established farmland in the Wheatbelt.	P. Brown
49/86	P85 Species performance measurements Ricetti high mounds.	P. Ritson
50/86	Ricetti high mounds arboretum.	P. Ritson
51/86	Effect of salt leaching from low soil mounds on tree establishment.	P. Ritson



RPP No.	TITLE	PRINCIPAL INVESTIGATOR
52/86	Atriplex species trial.	P. Ritson
56/86	A pilot study to collect adult insect specimens boring in wandoo.	P. Brown/ P. Albone
63/86	The effects of ringbarking on <u>Eucalyptus wandoo</u> stems.	P. Brown/ P. Albone
78/86	Quarterly assessment of insect damage and selected chemical properties in relation to aging of the Wandoo leaf.	P. Brown
79/86	The effect of sowing depth on tree seed germination.	P. Brown
2/87	Eucalypt Agroforestry Trial (Busselton, Dinninup and Middlesex).	R. Moore
5/87	<u>E. sideroxylon</u> family/provenance trial.	R. Mazanec
7/87	Mound design for reforestation of saline seeps in the Wellington Catchment.	P. Ritson
8/87	<u>E. saligna</u> family/provenance trial.	R. Mazanec
13/87	Effect of superphosphate on the germination of a variety of eucalypt and Acacia species.	P. Brown
15/87	Field assessment of fungal canker damage to Wandoo on the Darling Scarp.	P. Brown/ P. Albone
16/87	Fertilizer Trial.	P. Ritson
21/87	Tree spacing trial on high mounds.	P. Ritson
25/87	Drainage trial.	P. Ritson
26/87	Optimum sowing technique for direct seeding native tree species.	P. Brown
28/87	Field assessment of pre and post emergent herbicides on a range of native tree species.	P. Brown
29/87	The effect of post emergent herbicides on a range of native tree species.	P. Brown
30/87	Species performance trial.	P. Ritson
31/87	Mound age trial.	P. Ritson
32/87	Mulching trial.	P. Ritson
56/87	Pyrethrum knockdowns of phytophagous insects on sapling wandoo.	P. Brown
40/87	Seedling containers trial.	P. Ritson
41/87	Fertilizer pellets trial.	P. Ritson
55/87	<u>E. globulus</u> coppicing trial.	P. Ritson
5/88	Species selection for difficult high saline/waterlogged sites.	P. Ritson
7/88	Hardpan ripping trial.	P. Ritson
8/88	Double ridge mound design trial.	P. Ritson
10/88	<u>E. microcarpa</u> family/provenance trial	R. Mazanec
48/88	<u>E. microcarpa</u> provenance trial	T. Birmingham/R. Mazanec
53/88	<u>E. muellerana</u> family/provenance trial	R. Mazanec
54/88	<u>E. muellerana</u> family/provenance trial	R. Mazanec
*	Use of the Mullen seeding machine for eucalypt establishment.	P. Brown
*	Field scale demonstration of direct seeding of a road verge in conjunction with the Main Roads Department, Narrogin.	P. Brown
*	The effect of mycorrhizal fungi and fertilizer on the early growth and survival of direct seeded <u>Eucalyptus camaldulensis</u> .	P. Brown/ R. Edmiston
(264.54)*	Flynn's Agroforestry Trial.	R. Moore
(264.52)*	Wellbucket Agroforestry trial.	R. Moore
(264.51)*	Effect of extensive tree planting on salt (Flynn's).	R. Moore
(264.53)*	Landscape trial (Flynn's).	R. Moore
11/89	<u>Ebotryoides</u> family/provenance trial	R. Mazanec

## SILVICULTURE

### Jarrah Forest

49/65	Growth rates of pile-sized jarrah in even-aged forest at various stockings.	S. Crombie
15/66	Jarrah pole thinning - young poles (chalk).	S. Crombie
1/77	Forest stand manipulation to increase water production.	S. Crombie
24/82	Enrichment planting trial.	G. Strelein
20/82	Comparison of the effects of a number of alternative silviculture prescriptions.	S. Crombie
17/83	Seasonal growth of jarrah.	S. Crombie
18/83	Jarrah seeding establishment trial.	G. Strelein
19/83	Fertilizing seeded jarrah.	G. Strelein
20/83	Jarrah planting establishment trials.	G. Strelein
23/83	Jarrah site classification project.	G. Strelein
12/84	Jarrah fertilizer trials 1984.	G. Strelein
13/84	Jarrah espacement and lignotuber development trial.	G. Strelein
16/83	Hydrological study of the Yarragil catchment relating quality and quantity of landscape and forest treatments.	S. Crombie
37/84	Comparison of round-up and Tordon timber control for killing standing jarrah and marri poles in summer.	S. Crombie
30/85	Rehabilitation of the dieback degraded Warren Catchment and its effect on water quality and quantity.	S. Crombie
34/85	The effect of delays between notching and application of roundup herbicide.	S. Crombie
35/85	Effect of concentration of herbicide and stand density on efficacy of Round-up for killing jarrah stump coppice by foliar spray.	S. Crombie
36/85	The effect of notch spacing on the success of notching with Round-up herbicide.	S. Crombie
37/85	Comparison of Round-up and Tordon timber control for killing standing jarrah and marri poles in winter.	S. Crombie
39/85	The effect of Round-up dose on its ability to kill standing jarrah and marri poles in winter using the notching method.	S. Crombie
40/85	The effect of coverage of foliar spray of Round-up on its ability to kill coppice.	S. Crombie
41/85	The effect of fire on the success of notching jarrah and marri with Round-up herbicide.	S. Crombie
3/86	Response of hydrologically important measures of forest density.	S. Crombie

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
6/86	Jarrah lignotuber and root development study.	G. Strelein
30/86	Effect of Round-up dose on ability to kill standing jarrah and marri.	S. Crombie
31/86	Effect of Round-up dose.	S. Crombie
43/86	Effects of site preparation inoculation and timing of fertilizer.	G. Strelein
3/87	Study of genetic variation in growth and form of jarrah.	R. Mazanec
6/87	Jarrah family/provenance trials.	R. Mazanec
2/88	Jarrah pole thinning (Inglehope)	S. Crombie
11/89	Survey of genetic structure of main range jarrah forest using isozymes	R. Mazanec
<b>Karri Forest</b>		
28	Genetic variability and breeding systems in karri	D. Coates
26/78	Karri provenance trials.	R. Mazanec
15/82	Karri spacing experiment: Naim	P. Hewett
3/84	Karri spacing experiment - Manjimup: The effect of thinning fertilization and coppice control on growth and form of crop trees	P. Hewett
25/85	Basal area thinning experiment - Treen Brook	P. Hewett
19/86	Karri site classification.	G. Inions
3/89	The effect of thinning and fertilizing on the growth and form of crop trees on a 21 year old regrowth karri stand	P. Hewett
*	Shetlercup saving of <u>E. diversicolor</u> seed in regeneration coupes.	P. Hewett
<b>Pine</b>		
16/58	<u>P. pinaster</u> growth trial at Gngangara.	T. Butcher
19/62	<u>P. pinaster</u> seed orchards No. 1 Joondalup, No 2 Mullaloo.	T. Butcher
3/65	<u>P. pinaster</u> provenance trial at Gngangara	T. Butcher
20/65	Basal area control of thinning in <u>P. pinaster</u> , Bassendean sands.	T. Butcher
21/65	<u>P. pinaster</u> progeny trials widespread throughout SW Australia.	T. Butcher
27/65	<u>P. radiata</u> early thinning for particle board.	R. Moore
7/66	<u>P. radiata</u> non-commercial thinning.	R. Moore
12/66	<u>P. radiata</u> first thinning study.	R. Moore
48/66	Establishment of large pilot plots for <u>P. pinaster</u> .	T. Butcher
54/66	Basal area control of thinning in <u>P. pinaster</u> .	T. Butcher
17/67	<u>P. pinaster</u> response to phosphate on leached Bassendean sands.	T. Butcher
25/67	Bussel's arboretum at Collie.	R. Moore
26/67	Meribup arboretum at Manjimup.	R. Moore
27/67	Asplin's arboretum at Nannup.	R. Moore
20/68	Hydrology in <u>P. pinaster</u> stands.	T. Butcher
34/68	<u>P. radiata</u> seed orchard at West Manjimup.	T. Butcher
16/69	Pine establishment trial at Mt Cooke.	T. Butcher
21/71	<u>P. radiata</u> international gene pool progeny test (RS4 and RS5).	T. Butcher
22/71	<u>P. radiata</u> progeny trials throughout SW Australia.	T. Butcher
29/71	Productivity of second rotation pine at Gngangara and Grimwade.	T. Butcher
8/72	Fertiliser and thinning for <u>P. pinaster</u> on Bassendean grey sand.	T. Butcher
19/72	<u>P. radiata</u> genetics yield trial.	T. Butcher
20/72	<u>P. pinaster</u> genetics yield trial.	T. Butcher
15/73	Grazing and forestry combination in Blackwood Valley.	R. Moore
23/73	Subsequent fertilisation of <u>P. pinaster</u> on yellow sands.	T. Butcher
10/75	Agroforestry plan for Chapman's Lease.	R. Moore
20/75	Pilot plots of <u>P. radiata</u> at Moore River.	T. Butcher
20/76	Early fertilization of <u>P. pinaster</u> on marginal sites.	T. Butcher
21/76	Fertilization of adolescent <u>P. pinaster</u> on yellow sands.	T. Butcher
23/76	Fertilization of adolescent <u>P. pinaster</u> on grey sands.	T. Butcher
2/78	Agroforestry trial at Wonnerup.	R. Moore
20/78	Agroforestry regimes with <u>P. radiata</u> .	R. Moore
29/78	<u>P. radiata</u> provenance trial at Busselton [RX. 6(1979)].	T. Butcher
30/78	<u>P. radiata</u> genetic variation in dieback resistance.	T. Butcher
25/79	Provenance trials of <u>P. taeda</u> and <u>P. serotina</u> in sunkland.	T. Butcher/ M. Stukely
4/80	Agroforestry trial jarrahwood.	R. Moore
7/80	Strip planting of pines for agroforestry.	R. Moore
26/80	<u>P. pinaster</u> high pruning trial.	T. Butcher
2/81	Timing of fertiliser for maximum response in <u>P. pinaster</u> .	T. Butcher
4/81	Agroforestry trial in Wellington Catchment.	R. Moore
10/81	Agroforestry species trial Vasse 2.	R. Moore
2/82	Silviculture alternatives for fuel reduced buffers.	R. Moore
5/82	Comparison of silvicultural regimes for Sunkland <u>P. radiata</u> .	R. Moore
7/82	<u>Pinus pinaster</u> second rotation studies.	T. Butcher
9/82	Forms of nitrogen nutrition for <u>P. radiata</u> .	J. McGrath
19/82	Phosphorus regimes for pastured pine.	J. McGrath
21/82	Pine progeny trials in the Wellington catchment.	T. Butcher
33/82	Pine cuttings for agroforestry.	R. Moore
42/82	Agroforestry trials at Esperance.	R. Moore
44/82	Phase 3 pine species trial for Sunkland (4 species).	R. Moore
45/82	Effect of pruning on wide spaced <u>P. radiata</u> .	R. Moore
3/83	Comparison of form and set lift pruning in <u>P. radiata</u> .	R. Moore
6/83	Effect of <u>P. radiata</u> thinning on wind stability.	R. Moore
7/83	Early thinning of <u>P. radiata</u> on clover in Sunklands.	R. Moore
15/83	Combination of <u>Alnus</u> sp. and <u>P. radiata</u>	J. McGrath
25/83	Adjacent 1R/2R pinaster on good/marginal sands at Yanchep.	T. Butcher
29/83	Cultivation and fertilisation of marginal <u>P. pinaster</u> sites at Pinjar.	T. Butcher
28/83	Effect of initial stocking on future growth of <u>P. radiata</u> crop trees.	R. Moore
30/83	<u>P. radiata</u> non commercial thinning.	R. Moore

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
39/83	Screening established <i>P. radiata</i> for dieback resistance.	M. Stukely
14/84	Sunkland site trial <i>P. radiata</i> Phase III.	P. Jenkins
1/85	Nitrogen source distribution and effect on <i>P. radiata</i> growth	J. McGrath
8/85	<i>P. radiata</i> response to N and P after thinning on red loams.	J. McGrath
17/85	Phosphorus supply and concentration in <i>P. radiata</i> needles.	J. McGrath
2/86	Timber and agricultural production from two stand densities of pine agroforestry in the Manjimup area.	R. Moore
9/87	Timing of fertilization in thinned <i>P. radiata</i> .	J. McGrath
10/87	Frequency of fertilization in thinned <i>P. radiata</i> .	J. McGrath
11/87	The effect of thinning and fertilization on growth of <i>P. radiata</i> .	J. McGrath
33/87	Initial Fertilizer requirements for <i>P. radiata</i> on the South-Coast.	J. McGrath
18/88	Initial weed control and fertilization of <i>P. radiata</i> on the South Coast.	J. McGrath
43/88	Drought survey in the Blackwood Valley pine plantations	J. McGrath
*	Chemical emasculation of <i>P. radiata</i>	T. Butcher
*	Search 85 radiata breeding population	T. Butcher

## WETLANDS AND WATERBIRDS

*	Analysis of data from the 1981/85 Waterbird Survey project and data on physical characteristics of wetlands to determine how physical parameters affect waterbird usage of wetlands and to define the ecological preferences of individual waterbird species.	S. Halse
*	Surveys of aquatic invertebrates in the South west to gain a preliminary idea of the conservation status of different groups and species and to develop an understanding of how the physical characteristics of a wetland affect its species richness and composition.	S. Halse
*	Measurement of pesticide levels in the environment and biota of Herdsman Lake and other metropolitan lakes. Joint project with Dr J. Davis (Murdoch University) and Mr. G. Ebell (Chemistry Centre W.A.).	S. Halse
*	Study of dietary selection in waterfowl in relation to availability of potential foods.	S. Halse
*	Ostracod taxonomy.	S. Halse
*	Description of vegetation of wetlands of South west to provide data for long-term monitoring. Joint project with Dr. P. Wilson (Herbarium).	S. Halse
*	Publication of results of the 1986-88 joint CALM-RAOU surveys of remote wetlands of probable international importance. (RAOU).	J. Lane
*	Publication of results of 1986-88 survey of egret breeding colonies in Western Australia. (RAOU).	J. Lane
*	Publication of results of Lake Muir wetlands and Australasian Bittern surveys. (RAOU).	J. Lane
*	Examination of levels of exposure of native waterfowl to lead shot. Incidence of ingested lead pellets and lead levels in wing bones is being studied.	J. Lane
*	Annual monitoring of water levels and water quality of a sample of south-west wetlands as a basis for determination of duck shooting seasons and as a part of CALM's broader program of monitoring of the condition of the conservation estate.	J. Lane
*	Publication of results of 1986-88 surveys of waterbird usage of a number of important, poorly known, wetland sites in south-western Australia (RAOU).	J. Lane
*	Investigation of potential for lowering salt levels of Yenyenning Lakes (Yenyenning Lakes Inter-Departmental Working Group).	J. Lane
*	Preparation of waterbird protection guidelines for Vasse and Wonnerup estuaries.	J. Lane
*	Assess the potential for harvest of Kimberley populations of <i>Crocodylus porosus</i> and <i>C. johnstoni</i> .	J. Lane
*	Surveys of aquatic invertebrates in the fringing marsh of Leschenault Inlet and the diet of waterbirds in the Inlet to determine the effects of various methods of mosquito control on conservation values.	S. Halse

## WOOD UTILIZATION

30/82	Wood quality of pinaster and radiata pine.	G. Siemon
26/84	To compare the depth of sapwood with the depth of Copper chrome arsenic (C.C.A.) preservative penetration into regrowth jarrah posts.	G. Brennan
29/84	The investigation of the amount of log end splitting of mature and regrowth W.A. sheoak storing under water spray or in a dry stockpile.	G. Brennan
18/85	To investigate the amount of moisture loss, growth stress alleviation in regrowth, jarrah, karri and marri stored under water spray.	G. Brennan
27/85	The seasoning of mature jarrah by tunnel kilning and by air drying.	G. Brennan
28/85	The seasoning of regrowth jarrah, marri and karri by tunnel kilning and by air drying.	G. Brennan
7/86	Sawmilling and slicing trial on thinnings from Inglehope Plots.	G. Brennan
8/86	Moisture content of Jarrah logging residues.	G. Brennan
9/86	Effect of drying method on Lyctus susceptibility of W.A. sheoak and regrowth karri.	G. Brennan
26/86	Strength properties of regrowth eucalypts.	G. Siemon
41/86	Durability of Western Australian grown timber species.	G. Siemon
42/86	Sawn graded recoveries from <i>P. radiata</i> grown in agroforestry stands.	G. Siemon
71/86	Assessment of volume and product recovery after sawmilling and stockpiling.	K. White (Forest Resources)
18/87	Sawing regrowth Karri from areas of high, medium and low site qualities and differing ages.	G. Brennan
6/88	Seasoning - Pre-drying eucalypt timbers from green to below fibre saturation point (f.s.p.) using a batch kiln.	G. Brennan
14/88	Effect of drying treatment, M.C. and reconditioning on regrowth jarrah.	A. Thomson
15/88	Effect of blue stain on strength of <i>P. radiata</i> power poles.	D. Donnelly (Forest resources)
16/88	Adhesives for manufacturing of jarrah furniture blanks.	P. Newby (Forest Resources)

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
17/88	Sawmilling - effect of saw gauge, packing method and tensioning method.	K. White (Forest Resources)
19/88	Regrowth Karri stockpiling trial.	L. Mathews (Forest Resources)
21/88	Sawn recoveries from crown logs of <i>Pinus radiata</i>	D. Thomson
45/88	Assessment of the use of edge-jointed regrowth jarrah panels for furniture manufacture.	D. Challis (Forest Resources)
46/88	Brown wood in karri.	E. Davison
49/88	Investigation of stability of regrowth jarrah panels made from boards.	P. Newby (Forest Resources)
50/88	Testing stability of regrowth jarrah panels under different equilibrium moisture contents.	"
51/88	Timber processing - compare WURC operating rules with USA rules and specifications.	"
52/88	Timber processing - edge and free jointing regrowth jarrah boards into furniture.	
65/88	Evaluation of regrowth eucalypt log degrade after six months storage.	K. White (Forest Resources)
2/89	Effect of degrade in mature jarrah flitches on veneer recoveries.	G. Siemon
4/89	Sawn graded recoveries from a sawmilling trial of regrowth jarrah and karri.	K. White (Forest Resources)
14/89	Field survey of incidence of brown wood in regrowth karri.	E. Davison

## Appendix III

### Directory of Expertise of Permanent Professional and Technical Staff

\* indicates professional staff

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* Abbott, I	Insect ecology, bird ecology, Jarrah ecology, earthworm ecology, island biogeography, soil/litter invertebrate fauna.
Alford, J	W.A. Tremandraceae.
* Algar, D	Fox biology and control, macropod ecology and management.
Annels, A	Plant identification.
* Armstrong, J	Plant taxonomy, Rutaceae, plant phylogeny (cladistics), pollination ecology, phytochemistry
* Bartle, J	Evapotranspiration of trees, tree cropping systems for farms, water resources - quality and quantity (salinity, nitrification).
Birmingham, T	Chemical usage, firearms.
* Brennan, G	Sawmilling, seasoning, wood properties.
Bromilow, B	Control of exotic predators, population census techniques, radio-telemetry, computing.
Brown, A	Flora conservation, rare and endangered species, wildflower industry, orchid identification and biology, horticulture of native plants.
* Burbidge, AA	Mammals, <i>Beaufortia</i> , <i>Regelia</i> , tortoises, turtles, crocodiles, seabirds, islands, endangered fauna, deserts, Noisy Scrub-bird, Kimberley Reserves, Aboriginal knowledge and liaison.
* Burbidge, AH	Bird distribution, ecology and conservation.
Burbidge, T	Insect identification.
* Burrows, N	Fire behaviour (forests, hummock grasslands), fire effects (forests), fire management.
* Butcher, T	Tree breeding, genetics, softwood silviculture, hydrology.
Calvert, G	Silviculture.
* Christensen, P	Softwood silviculture, hardwood silviculture, forest pathology, forest ecology, fire effects.
* Choo, M	Computing.
* Coates, D	Genetics, cytogenetics, evolutionary biology, plant systematics, plant population biology, conservation biology, protein electrophoretic and chromosome techniques, flora identification.
Crane, C	Plant diseases.
Cranfield, R	Identification and survey of arid zone flora, general identifications, rare flora survey.
* Crombie, S	Jarrah, karri water relation, dieback impact, tree growth & forest pathology.
Curry, S	Botanical history - Alan Cunningham.
* Davison E	Plant diseases (mycological).
Dillon, M	Plot register
* Farr, J	Entomology.
* Friend, G	Disturbance ecology, fauna/habitat relationships, faunal sampling methodology, small vertebrates, invertebrates.
* Friend, T	Mammals, rare fauna, radio tracking, captive breeding, soil zoology, species studies, numbats, bandicoots.
Fuller, P	Birds, birds' eggs (oology), deserts, explosives, Western Swamp Tortoise, Aboriginal liaison (especially desert).

- Gardner, J** Small mammals and reptiles of the arid zones.
- \* **Gibson, N** Plant ecology/biogeography, conservation biology.
- Giles, R** Jarrah forest water relations.
- \* **Gioia, P** Computing
- \* **Glossop, B** Seasoning, computing, statistics, biometrics.
- \* **Halse, S** Waterbirds, wetlands, aquatic invertebrates, avian population dynamics, duck hunting, avian pests, Ostracoda, pesticides.
- \* **Hewett, P** Karri forest silviculture.
- Hill, T** Plant diseases.
- Hingston, R** Pine silviculture.
- \* **Hopkins, A** Fire ecology, rehabilitation, kwongan, wheatbelt (Tutanning, Kellerberrin), southcoast (Two Peoples Bay, Stirling Range), northern sandplains (Mt Lesueur - Eneabba), Islands (Recherche Archipelago), mangroves.
- \* **Hopper, S** Phytogeography, flora conservation, flora identification (especially orchids and eucalypts), granite outcrop plants, plant systematics and evolution, pollination ecology, rare and endangered flora.
- Jenkins, P** Agroforestry, pine silviculture.
- \* **Keighery, G** W.A. Liliaceae, Apiaceae, *Opercularia*, *Chamelaucium* - *Darwinia*.
- \* **Kenneally, K** Plant taxonomy, Kimberley flora.
- \* **Kinnear, J** Animal ecology, animal nutrition, animal physiology, microbiology, exotic predators.
- \* **Koch, B** Plant taxonomy: Kimberley flora, Jarrah forest.
- \* **Lander, N** Plant taxonomy: Asteraceae (especially *Olearia* and allied genera), malvaceae (especially *Plagianthus* alliance).
- \* **Lane, J** Waterbirds, wetlands, midge (chironomid) management, duck hunting, crocodile harvesting and management.
- Langley, M** Fire/flora ecology.
- Leftwich, T** Radio-telemetry, dietary analysis, biological survey techniques, exotic and feral animal control techniques.
- Liddelow, G** Fauna, Perup field course.
- Lyons, M** Plant biology/ecology, pollination biology.
- \* **Macfarlane, T** Plant taxonomy: *Wurmbea*, *Lomandra*, *Burchardia*, *Chamaexeros*, *Haemodorum*, *Tribonanthes*, *Pultenaea*.
- Maisey, K** Forest mammals.
- \* **Marchant, N** Plant taxonomy: *Chamelaucium*, *Darwinia*, *Drosera*, aquatic angiosperms, Botanical history.
- \* **Maslin, B** Plant taxonomy: *Acacia*.
- Mason, M** Jarrah forest fauna.
- \* **Mazanec, R** Jarrah, provenance variation and testing, rehabilitation, species selection.
- \* **McCaw, L** Fire behaviour and effects in Karri forest and shrublands.
- \* **McGrath, J** Plant nutrition, chemical analysis, tree water relations.
- \* **McKenzie, N** Biogeography, community ecology, Australian mammals.
- Mitchell, D** Small vertebrates, invertebrates, faunal sampling methodology, computing.
- \* **Moore, R** Agroforestry, pine silviculture.
- \* **Morris, K** Biology of native mammals (especially rodents), physiology, island fauna biogeography and management.
- Munro, D** Waterbirds, wetlands, duck hunting.

- Onus, M** Population census techniques, dietary analysis, biological survey techniques, exotic and feral animals control techniques, computing, radiotelemetry.
- \* **Patrick, S** Cannabis identification, toxic plants, general identifications (plants), naturalized flora of Western Australia..
- \* **Pearson, D** Aboriginal liaison, arid zone reptiles and mammals, hummock grassland flora.
- Pearson, G** Waterbirds, wetlands, midge and mosquito control.
- \* **Perry, G** Plant taxonomy: naturalized flora, Loganiaceae, Plant names.
- \* **Pigott, P.** Remnant bushland weeds, fire and disturbance effects, ARC-INFO, urban reserve management, *Eucalyptus gomphocephala*.
- Portlock, C** Jarrah forest hydrology and jarrah growth.
- \* **Prince, R** Kangaroo management, dugongs, marine turtles, Shark Bay area, wildlife management, Aboriginal liaison.
- Read, B** Statistics and data handling.
- Robinson, A** Fire control and suppression, Manjimup plot register.
- Rolfe, J** Reptile distribution and identification.
- Rooney, J** Safety, chemical usage.
- \* **Rye, B** Plant taxonomy : Thymelaeaceae.
- Sanders, C** Tree breeding.
- \* **Shearer, B** Plant diseases, *Phytophthora*, *Armillaria*, cankers, crown decline, hygiene, epidemiology, control, forests, woodlands, risk and hazard rating.
- \* **Siemon, G** Wood utilization.
- Sokolowski, R** Field herbaria methodologies, flora identification.
- \* **Start, T** Arid zone ecology, mammals (especially order Chiroptera), birds, Odonata, Aboriginal liaison, National Park/Nature Reserve Management.
- \* **Stoddart, J** Marine biology, genetics, corals, invertebrate reproduction, recruitment.
- Stritof, J** Tree breeding.
- \* **Stukely, M** Plant diseases.
- Tay, F** Mycology, wood quality, general pathology.
- Van Heurck, P** Insect identification.
- \* **Van Leeuwen, S** Flora conservation, rare and endangered flora, flora identification, fire ecology, population dynamics, pollination ecology.
- Ward, B** Fire behaviour forests, fire management.
- \* **Ward, D** Mathematical statistics, biometric experimental design.
- \* **Wardell-Johnson, G** Fauna, Walpole- Nornalup National Park.
- Wheeler, I** Noisy scrub bird translocation program.
- \* **Wheeler, J** Plant taxonomy : *Hibbertia*.
- Whitford, K** Forest leaf area, computing and statistics.
- Williams, A** Surveys, small mammals and other vertebrates, taxidermy.
- \* **Williams, M** Mathematical statistics, biometric experimental design.
- \* **Wilson, P** Plant taxonomy: Rutaceae, Chenopodiaceae, *Helipterum*, *Helichrysum*, Plant names.
- Wong, L** Chemical analysis.
- \* **Wood, Y** Computing

## Appendix IV Representation of Research Staff on Committees

### Research Scientists

Internal	External Representing Department	External Non-Departmental
<b>IAN ABBOTT</b> Research Division Policy Group; Scientific Publications Editorial Committee Library Committee	AFC-RWG 8 - Forest Entomology	Royal Society of WA - Editor of Journal Aust Entomological Soc - member of editorial board of journal
<b>JIM ARMSTRONG</b> Research Division Policy Group Herbarium Publications Committee (Chair)	Floriculture Industry Advisory Committee (Dept. of Agriculture) CONCOM WG on Endangered Flora	Aust Academy of Science 'Flora of Australia sub-committee' of the National Committee for Plant Sciences Aust Flora Foundation (Director) Aust Flora Foundation Research Committee National Forensic Resource Registrant of the National Police Research Unit
<b>JOHN BARTLE</b> Research Division Policy Group (as required); Rehabilitation Program Northern Forest Region, Regional Leaders' Group	Integrated Catchment Management Policy Group (Deputy) Steering Committee for research on Land Use and Water Supply Forest Management Subcommittee Bauxite Subcommittee Water Resource Catchment Rehabilitation Sub-committee Coastal Plain Land Management Subcommittee Peel Inlet Management Authority Peel-Harvey Implementation Steering Group	
<b>GARY BRENNAN</b> WURC Management Committee	Timber Seasoning Working Group Wood Properties Research Working Group	
<b>ALLAN BURBIDGE</b> Aerial Photography Committee; Endangered Fauna Working Group		RAOU WA Group Research Committee
<b>ANDREW BURBIDGE</b> Policy Directorate Research Division Policy Group; Computer Policy Committee; Research Computer Users Group (Chair); Conservation Lands Acquisition Committee; National Parks and Nature Conservation Trust Fund Committee	Commonwealth Advisory Committee on Endangered species Biological Surveys Committee (Chair) CONCOM WG on Endangered Fauna Scientific Advisory Committee, World Wildlife Fund Australia	ANZAAS, State Executive Committee IUCN Species Survival Commission, Australian Marsupials Specialist Group IUCN Species Survival Commission, Tortoise & Freshwater Turtle Specialist Group
<b>NEIL BURROWS</b> Perup Ecology Centre; Regional Leaders Group, Southern Forest Region; Fire Management on Nature Conservation Lands. National Workshop Co-convenor	AFC - RWG6 - Fire Management	
<b>TREVOR BUTCHER</b>	AFC - RWG Forest Genetics Technical Committee - Gngara Mound Recharge Southern Tree Breeding Association Eucalyptus Globulus Breeding Association	
<b>MIKE CHOO</b> Research Division Computer Users Group CALM Corporate Data Steering Committee	LISSC - Vax Users Group WALIS - Restricted Site Databases	
<b>PER CHRISTENSEN</b> Research Division Policy Group	Research Steering Committee Australian Forestry Council Directors of Research Committee WURC Policy Panel Aquatic Ecosystems Research Sub-committee	
<b>DAVID COATES</b> Wildflower Industry Review Committee.	Floriculture Industry Advisory Committee	
<b>STUART CROMBIE</b> Scientific Publications Editorial Committee	Research Steering Committee - Bauxite Sub-committee	



Internal	External Representing Department	External Non-Departmental
<b>GORDON FRIEND</b> Roadside Vegetation Conservation Workshop Committee W.A. Fire Management Workshop CALM/CSIRO Research Co-ordinating Committee		
<b>TONY FRIEND</b> Dryandra State Forest Planning Team	Numbat Breeding Management Advisory Committee	
<b>NEIL GIBSON</b>	Interdepartmental Committee on Mineral Exploration in D'Entrecasteaux National Park	
<b>STUART HALSE</b> Herdsman Lake Management Plan Team	Gnarangara Mound Wetlands Technical Subcommittee Land Salination Working Group (Research Steering Committee on Land Use and Water Supply) WAWA Research Projects Steering Committee Jandakot Groundwater Discussion Group	
<b>PENNI HEWETT</b>	AFC - RWG4 - Native Forest Silviculture (Secretary)	
<b>ANGAS HOPKINS</b> Two Peoples Bay N R Planning Team Monitoring Policy Implementation Committee	CONCOM WG on Mallee Conservation Mineral Sands Agreements Rehabilitation Co-ordinating Committee	Ecological Society of Australia Council Organizing Committee, ESA Biennial Conference (1988)
<b>STEVE HOPPER</b> Research Division Policy Group Scientific Publications Editorial Committee Wildflower Industry Review Committee Fitzgerald River National Park Management Plan Team Endangered Flora Consultative Committee	EPA Task Force on Red Book Reserve Recommendations EPA Working Group on Land Releases Australian Orchid Foundation Research Committee AustralianFlora Foundation Research Committee; IUCN Species Survival Commission Orchid Specialist Group IUCN Species Survival Commission Australasian Plant Specialist Group	Australian Pollination Ecologists Society - Secretary
<b>GREG KEIGHERY</b> Landscape Committee		
<b>KEVIN KENNEALLY</b> Kimberley Flora Committee Herbarium Garden Committee (Chairman)	W.A. Government Biological Surveys Committee Herdsman Lake Management Committee Natural Environment Evaluation Panel (WA) of the Australian Heritage Commission	W.A. Naturalists' Club - Co-ordinator Wongan Hills Biological Survey Committee W.A. Naturalists' Club - Editor Scientific Journal and Handbooks W.A. Gould League - President
<b>BEVERLEY KOCH</b> Kimberley Flora Committee Kingia Editorial Board		
<b>NICHOLAS LANDER</b> Scientific Publications Editorial Committee Herbarium Publications Committee		
<b>JIM LANE</b> Vasse-Wonnerup Working Group	Midge Research Steering Committee (Chair) CONCOM WG on International Agreements Relating to Migratory and Wetland Birds Yenyening Lakes Working Group (Chair) Associated Minerals Consolidated Wetlands Management Committee	
<b>TERRY MACFARLANE</b> Nuytsia Editorial Board		Australian Systematic Botany, CSIRO Editorial Committee
<b>NEVILLE MARCHANT</b> Nuytsia Editorial Board Herbarium Publications Committee		Murdoch University Grounds Committee Secretary, South-east Asian Botanical Program (UNESCO) Member, Scientific Advisory Board, Asian Co-ordinating Group for Chemistry, Chemical Research Communications.
<b>JOHN MCGRATH</b>	AFC - RWG3 - Forests Soils and Nutrition AFC - RWG5 - Plantation Silviculture	

Internal	External Representing Department	External Non-Departmental
<b>LACHLAN MCCA</b> Regional Leaders Group - Southern Forest Region Protection Branch Meetings Fire Management on Nature Conservation Lands National Workshop Co-convenor	AFC - RWG6 - Fire Management (Secretary)	
<b>NORM MCKENZIE</b> Pastoral Areas Conservation Steering Committee	Biological Surveys Committee	
<b>RICHARD MOORE</b> Central Forest Region, Regional Leaders' Group	Water Resource Catchment Rehabilitation Subcommittee WA Agroforestry Working Group National Agroforestry Working Group	International Tree Crops Institute (Committee Member)
<b>KEITH MORRIS</b>	Pilbara Regional Herbarium Committee Burrup Peninsula Working Group NW Island Management Committee	
<b>SUSAN PATRICK</b> Herbarium Publications Committee Kingia Editorial Board		
<b>GILLIAN PERRY</b>	Biological Control Committee (Department of Agriculture)	Special Committee on lectotypification
<b>PATRICK PIGOTT</b> CALM Rural Advisers Committee		
<b>BOB PRINCE</b> Kangaroo Management Review Group of Fauna Committee, NPNC Dampierland Aboriginal Training Program - Project Work Working Group, Wildlife Conservation Act Revision Marine Working Group	IUCN Species Survival Commission, Sirenia Specialist Group	
<b>BARBARA RYE</b> Kimberley Flora Committee		
<b>BRYAN SHEARER</b> Dieback Photography Committee	Research Steering Committee - Forest Management Sub-committee Department of Agriculture - P. cinnamomi Working Party AFC -RWG7 - Forest Pathology	
<b>GRAEME SIEMON</b> Wood Utilization Research Centre Management Committee	WA Regional Committee WA Softwood Producers Association Technical Committee Standards Australia WA Pesticides Advisory Committee (Reviewer)	
<b>TONY START</b> Research Division Policy Group CALM Training and Career Development Group Hammersley Range N.P. Planning Group Rudall River N.P. Planning Group	(Perth) Millstream Management Committee	
<b>JIM STODDART</b> Marine Working Group Marine Parks and Reserves Selection Working Group Regional Leaders Group, Metro	Interdepartmental Committee on Aquaculture	International Society for Reef Studies - Editorial Board 'Coral Reef'
<b>DAVID WARD</b> Corporate Data Steering Committee Research Division, Computer Users Group		
<b>GRANT WARDELL-JOHNSON</b> Task force into the mapping of defined community types in Karri regeneration	AFC - RWG12 - Forest Fauna Walpole-Nornalup National Park Management Plan Committee	
<b>JUDITH WHEELER</b> Kimberley Flora Committee		
<b>MATTHEW WILLIAMS</b> Research Division, Computer Users Group		
<b>PAUL WILSON</b> Library Committee		Bureau of Flora and Fauna Flora of Australia Committee International Seed Testing Association Nomenclature Committee Australian Systematic Botany Society: Flora of Central Australia Committee

## Technical Support Staff

Internal	External Representing Department	External non- Departmental
<b>TONY ANNELS</b>		Manjimup Natural History Club
<b>ANDREW BROWN</b> Wildflower Industry Review Committee	WA Native Orchid Study and Conservation Group Endangered Orchid Species Working Group	
<b>RAY CRANFIELD</b> Herbarium Garden Committee CALM Safety Committee	Department of Agriculture Laboratory Safety Committee	
<b>RICHARD FAIRMAN</b> Safety Committee		
<b>PHIL FULLER</b> Chemicals Committee		
<b>BRETT GLOSSOP</b> Computer Users Group	Timber Seasoning Working Group	
<b>GRANT PEARSON</b>	Mosquito Control Review Committee	
<b>BETH READ</b> Research Division, Computer Users Group		
<b>RON SOKOLOWSKI</b> Wildflower Industry Review Committee		
<b>KIM WHITFORD</b> Research Division, Computer Users Group		
<b>ANDY WILLIAMS</b> Firearms Policy Committee		
<b>YVONNE WOODS</b> Research Division, Computers Users Group	Husky Hunters Users Group	

## Appendix V

### Allocation of Time by Permanent Staff to Research and Extension

Research within the Division is divided into three categories i.e. actual research activities, extension within CALM and extension outside CALM. These areas are defined as follows:

**Research Activities:** - this is the time spent on actual research and includes planning, organizing, data collection, data analysis and writing up.

**Extension within CALM:** - this includes time spent on sitting on committees within CALM, answering queries from within CALM, and communicating research results to managers and other staff.

**Extension outside CALM:** - this includes time spent on representing CALM on external committees, attending seminars outside CALM, and attending to public enquiries

The tabulation below indicates the break-up of time (%) for both professional and technical staff in these areas.

*\*indicates Professional Staff*

	Research Activities	Extension within CALM	Extension outside CALM	Administration
*Abbott, I	40	10	10	40
Alford, J	80	15	5	
*Algar, D	85	10	5	
Annels, A	80	10	10	
Armstrong, J.	20	25	15	40
*Bartle, J	30	20	20	30
Birmingham, T	95	4	1	
*Brennan, G	85	7.5	7.5	
Bromilow, B	100			
Brown, A	60	30	10	
Buehrig, R	95	5		
*Burbidge, AA	20	35	5	40
*Burbidge, AH	80	15	5	
Burbidge, T	90	5	5	
*Burrows, N	80	5	5	10
*Butcher, T	80	10	10	
Calvert, G	100			
*Chapman, A (0.4 FTE)	100			
*Choo, M	90	10		
*Christensen, P	20	25	15	40
*Coates, D	60	15	15	10
Crane, C	90	10		
Cranfield, R		48	50	2
*Crombie, S	80	10	10	
Cully, M	100			
Curry, S.	100			
*Davison, E	75	25		
Dillon, M	94	5	1	
Dumbrell, I	100			

	Research Activities	Extension within CALM	Extension outside CALM	Administration
Fairman, R	98	2		
Farr, J	80	10	10	
Freeman, I	98	2		
*Friend, G	80	15	5	
*Friend, J	70	10	10	10
Fuller, P	90	5	5	
Gardner, J.	85	10	5	
Gibson, N.	80	15	5	
Giles, R	68	2		30
*Gioia, P	90	10		
Glossop, B	85	7.5	7.5	
*Halse, S	50	30	20	
*Hewett, P	80	15	5	
Hill, T	100			
Hingston, R	90	10		
*Hopkins, A	60	20	20	
*Hopper, S	25	15	20	40
Jenkins, P	70	10	10	10
*Keighery, G	60	20	10	10
*Kenneally, K	70	15	15	
Kennett-Smith, A	98	2		
Kinal, J	98	2		
*Kinnear, J	80	10	10	
*Koch, B (0.5 FTE)	60	20	20	
*Lander, N	85	5	10	
Langley, M	100			
*Lane, J	30	10	10	50
Leftwich, T	100			
Liddelow, G	70	15	15	
Lyons, M	90	5	5	
*Macfarlane, T	60	10	30	
Maisey, K	90	10		
*Marchant, N	80	10	10	
*Maslin, B	85	10	5	
Mason, M	95	5		
*Mazanec, R	95	5		
McArthur, S	100			
*McCaw, L	70	5	5	20
McDonald, D	100			
*McGrath, J	60	20		20
*McKenzie, N	80	10	10	
Mitchell, D	90	10		
*Moore, R	60	10	20	10
*Morris, K	80	10	10	
Munro, D	80	5	5	10
Neal, J	90	10		
Onus, M	95	5		

	Research Activities	Extension within CALM	Extension outside CALM	Administration
Parker, C (0.5 FTE)	100			
*Patrick, S	15	40	45	
*Pearson, D	85	10	5	
Pearson, G	65	10	5	20
*Perry, G	80	10	10	
*Piggot, P	60	20	20	
Portlock, C	94	2	4	
*Prince, R	80	10	10	
Rainbird, J (0.5 FTE)	100			
Read, B	80	10		10
Robinson, A	90	5	5	
Rolfe, J	95	2.5	2.5	
Rooney, J	70	5	5	20
*Rye, B (0.5 FTE)	90	5	5	
Sanders, C	90			10
Searle, J (0.5 FTE)	100			
*Shearer, B	68	10	2	20
*Siemon, G	60	10	10	20
Skinner, P	90		10	
Smith, R	100			
Sokolowski, R	85	5		10
Spencer, P	100			
*Start, T	35	15	10	40
*Stoddart, J	25	40	25	10
Stritoff, J	100			
*Stukely, M	60	40		
Tay, F	75	25		
Thomas, N	95		5	
Thomson, A	85	7.5	7.5	
Van Heurck, P	90	5	5	
*Van Leeuwen, S	90	10		
Vellios, C	100			
Ward, B	90	10		
Ward, C	100			
*Ward, D	90	10		
*Wardell-Johnson, G	70	15	15	
*Wheeler, J	90	5	5	
Whitford, K	88	2	10	
Williams, A	90			10
*Williams, M	90	10		
Wills, A	100			
*Wilson, P	100			
Wong, L	100			
Woods, Y	100			

## APPENDIX VI

### BENEFITS OF RESEARCH - SOME CASE STUDIES

Each revision of the Research Plan will include brief synopses of how research conducted by CALM has led to improvements in the conservation of species and/or the management of land in Western Australia.

#### Dugongs in Shark Bay

Dugongs were known to frequent Shark Bay, but it was only in the late 1970s as a result of specific surveys initiated by Research Branch of the former Department of Fisheries and Wildlife that the size of this population and its world-wide significance for conservation was recognized.

Following from the above research it was realized that future management for conservation would require more detailed information on biology and ecology of this population. With the resources available, active measures were taken to encourage interest of independent research workers and to gain external support for commencement of long term studies. This strategy was successful, and Shark Bay has since become the focus for an ongoing major study of the dugong.

Information obtained from the study in progress was of major importance in considering conservation of dugongs and the marine environment of Shark Bay in preparation of the Shark Bay Region Plan 1987, and in subsequent planning for implementation of the Plan adopted by the State Government in 1988. Complementary detailed population survey to establish a management bench mark is now to be implemented by CALM.

#### Outbreaks of Insects on Trees

It is well established from agricultural and forestry research on all continents that insect infestations significantly reduce crop yield. Trees experiencing chronic, moderate to severe, infestations of herbivorous insects suffer heavy defoliation, reduced photosynthetic capacity, and hence reduced wood growth. Also, certain species of borer can ruin wood standing in a forest and after extraction from forest.

Fortunately many of the problem wood-eating species occur in other states of Australia, and so there is a considerable body of research information available on termites, Powderpost beetle, Ips and Sirex. Often only minor adaptation of these research findings is required for their application to trees grown in, or wood used in, Western Australia.

Most of the forestry services in Australia have traditionally given meagre support to research into defoliating pest insects of trees. Consequently, few species have been well studied. The current major defoliators in WA are Jarrah Leafminer, Gumleaf Skeletonizer and Lerp, and the tree species involved are indigenous to the state. The Entomology Program is able to draw on valuable research already carried out into Jarrah Leafminer by CSIRO and into the other species in eastern Australia. But devising efficacious pest insect management obviously entails considerably more local research. There are no instant cures for insect outbreaks. Any remedies or preventive measures must be scientifically proven before their implementation can be considered.

Benefits of this research should include: retarding or preventing spread of outbreaks into healthy stands; reducing to acceptable levels the abundance of pest insects in those stands experiencing outbreaks; and refining management practices such as fire and thinning to disfavour initiation and continuation of outbreaks. The ultimate advantage is improved protection of stands of trees, both in the forests and woodlands of South-western Australia. Where timber production is a priority, better control of pest insects will ensure that wood decrement caused by insect outbreaks is minimized. Where conservation is a priority, crown deterioration resulting from insect infestation will be reversed.

CALM research into entomology has shown that Leafminer outbreaks over 20 years have reduced diameter increment of Jarrah poles; this confirmed an earlier study over 3 years carried out by CSIRO. Extensive surveys of forest near Manjimup have implicated rainfall and fire as the two most important environmental factors influencing the degree of Leafminer infestation. A similar survey indicates rainfall as a correlate of Gumleaf Skeletonizer infestation. Other research has shown that 5 years of infestation by Skeletonizer has not affected the biomass of any other insect group present in Jarrah crowns around Manjimup.

#### Plant Diseases

Dieback disease caused by *Phytophthora* species is one of the greatest threats to the ecology and conservation of susceptible plant communities of southwestern Australia. Widely distributed throughout the area bordered by Kalbarri in the north, Cape Arid in the south and Boyagin Rock to the east are plant communities infected with *Phytophthora* species. The destruction caused by *Phytophthora* species in southwestern Australia is an exceptional example of introduced pathogens of

wide host range causing great damage to diverse but mainly susceptible plant communities.

*Phytophthora cinnamomi* is the most destructive of the seven *Phytophthora* species that infect native plant communities in this state. Historically, the threat *P. cinnamomi* infection posed to timber production has received greatest attention. Thus more is known of the interaction between *P. cinnamomi* and the jarrah forest than for other *Phytophthora* species and plant communities.

Following the association of *P. cinnamomi* with Jarrah dieback in the mid 1900s, sites and seasons having favourable soil temperature and moisture conditions for survival and sporulation of *P. cinnamomi* were identified. This information aided the development of hygiene prescriptions aimed at preventing spread of the fungus.

The importance of *Banksia grandis* as reservoirs of inoculum and a buffered environment for survival of the fungus was determined. These findings lead to the use of *B. grandis* as indicator plants in the interpretation of aerial photographs. Further practical application was the possibility of reducing the rate of disease development in the forest by manipulating understorey composition to replace susceptible *B. grandis* by resistant legumes.

In 1982, *P. cinnamomi* was found at depth within the profile, often just above a horizon that impeded vertical percolation of water in upland areas. For the first time, disease behaviour in upland areas of the jarrah forest was related to site characteristics that influenced sporulation, survival and dispersal of the pathogen and the infection of jarrah. It is now recognised that upland jarrah forest is a mosaic of site types with different drainage characteristics that can influence development of the pathogen and infection of jarrah. The link between site characteristics and disease development has led to the identification of vegetation indicators for the prediction of disease hazard. Determination of the proportion of the uninfected forest occupied by low,

intermediate and high hazard will greatly assist planning. However estimates of the risk of infection and how quickly hazard will be expressed will require determination of the relationships between reproduction, survival and dispersal of the fungus and site environmental factors.

Conditions that favoured sporulation of *P. cinnamomi* in the soil and infection were often confused with those that affected symptom expression. In the first investigation and description of *P. cinnamomi* in 1922, invasion of woody tissue was described, but the relevance of this observation for *Eucalyptus* species was not appreciated until the early 1980s. Recognition that the fungus could invade the woody tissue of jarrah led to greater emphasis on the interactions between host and pathogen. Lesion development and resistant mechanisms in jarrah were described and the importance of host water status on the host pathogen interaction identified. This work led to studies on the relationships between the ecophysiology of jarrah and infection. Monitoring the physiological status of host plants on different sites under different conditions indicates how long some species are vulnerable to infection and invasion as the result of disturbance of silviculture treatments.

In recent years plant disease research has included *Phytophthora* species other than *P. cinnamomi* in a range of plant communities. Databases on the distribution and susceptibility of hosts have been developed for *Phytophthora* species occurring in woodlands and heaths. Factors affecting the rate of spread and population levels of *P. cinnamomi* in *Banksia* woodlands and the impact of *Phytophthora* species in south coast national parks are under investigation. Information gained will aid managers to assess hazard and the risk of infection. For the first time research into chemotherapy offers hope for the future. The immediate aim is to use chemicals to protect rare flora threatened by infection.