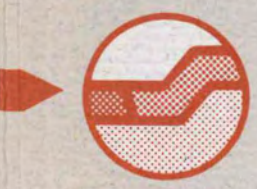
RESEARCH DIVISION

5 YEAR PLAN

JULY 1988

JUNE 1993



Department of Conservation & Land Management

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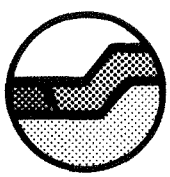

Department of
Conservation &
Land Management

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PREFACE

This is the second Research Plan of the Department of Conservation and Land Management.

Since the first Plan was completed in late 1986, careful reviews have been made of reseach priorities and projects. Reviews have taken place at two levels. Firstly, the members of each Program have met regularly to decide on priorities and plan co-operative projects within Programs. Secondly, the Research Division Policy Group arranged a detailed review of each Program during March and April 1988, which culminated in recommendations to Policy Directorate that were adopted in August 1988.

Many people have contributed to the preparation of the Research Plan. I particularly thank the Program Leaders, who wrote their sections, and Ian Abbott, who had overall responsibility for the preparation of the Plan.

I also thank Jeanette Gilmour, Margaret Wilke, Jill Pryde, Glenda Godfrey and Jan Imms for help in the preparation, typing and desk-top publishing of the document.

Andrew A. Burbidge
Divisional Manager, Research

30 June 1988

PART 1 INTRODUCTION

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, before the annual financial year estimates are required.

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 Five Year Plan fulfils this requirement for the Division of Research. The information in this plan is correct to 30 June 1988.

HISTORICAL OVERVIEW

The Research Division of the Department of Conservation and Land Management (CALM) was formed in 1985 through the amalgamation of research branches from the Forests Department and the wildlife section of the Department of Fisheries and Wildlife. The Division was further expanded in July 1988 when the Western Australian Herbarium was transferred from the Department of Agriculture to CALM under the control of the Divisional Manager, Research. The following is an overview of research in these organizations through to 1988. This overview is specifically related to broad research topics and staff growth as opposed to scientific and technical detail.

Forests Department

From the establishment of the Swan River settlement in 1829 until 1896 all forest related activities in the State were administered by the Lands Department. In 1896 a Woods and Forests section was created within the Lands Department with Mr J Ednie-Brown as Conservator. Mr Brown was succeeded by Mr C G Richardson in 1899. It was not until 1916 and the appointment of Mr C E Lane-Poole as Conservator that scientific principles in management and silviculture were brought into practice. The formation of the Department dates from the passing of the Forests Act in 1918 - the first permanent State Forests were dedicated, the first working plans for management were drawn up and regeneration measures in the cutover jarrah forest were initiated.

Fire control was commenced and a Forests Products Laboratory was set up at Crawley in 1921 to study problems of utilization. Unfortunately this laboratory lasted only a few years before it was transferred to Melbourne. The laboratory had, however, made headway in the growth of research into problems of utilization, seasoning, kiln drying, manufacture of paper pulp and tannin extract, establishment of specifications and grading rules and cooperation with Commonwealth authorities. In 1933 a second side of research, that of inquiry into problems of management, silviculture and nutrition in indigenous forest and plantations of exotics came into prominence. A comprehensive program of investigations entailing extensive field trials with statistical analyses of results was begun. Substantial research into fire weather forecasting and fire hazards commenced at Dwellingup in the mid 1930s. The outbreak of war in 1939 halted any continued active development. For many years after the war shortage of staff prevented the appointment of Research Officers and consequently work was limited to those studies made by officers in the course of their ordinary duties.

The main fields covered by investigation during the later years of the 1940's were various phases of pine afforestation and the growth of jarrah utilization. Experiments were conducted with nursery sterilization and combinations of fertilizers. A research station was set up at Dwellingup in 1948 for the study of jarrah growth. This was staffed by workers from the Forests Department and the Commonwealth Forestry Bureau. 1953 saw the establishment of the Pine Research Centre at Gnangara. Fundamental studies were also commenced on the effects of fire on growth.

By 1955 two senior and three junior officers were engaged almost wholly on research. The Perth section of the Research Branch, which for some years had operated from the then Native Affairs

Department in Wellington Street, moved to the Treasury Buildings.

The Perth office of the Research Branch functioned mainly as an extension unit in 1956 giving advice on tree planting, aspects of tree disorders, utilization, forest resources and forestry education. A Research Working Plan register was commenced to facilitate field working and office administration. 1957 saw the first figures indicating the effect of thinning in jarrah regrowth placed on record.

In 1958 research activities were expanded by the appointment of officers to study Jarrah silviculture, and the dry area aboreta. Four full-time and two part-time officers were employed wholly on research related activities. The decade spanning the 1960's saw a major surge of research activity occurring in the southern forest region. A new research laboratory was completed in Manjimup in 1968 and was staffed with three professional officers and ten technical assistants. In 1964 a silviculturist with two assistants operated from Collie investigating Radiata Pine plantation practice. Silviculture and pathology research continued to expand at Dwellingup.

In 1965 a new building was completed in Como. This became the headquarters for research, being titled the Institute for Forest Research and Protection. The nutrition section which originated at Dwellingup in 1948 was then transferred to Como. Chemical and biological laboratories, glasshouses and a seed handling unit were all included in the Como centre. General administration and supervision of the Wanneroo outstation all emanated from the Como laboratory. At this time Como had a staff of five professional officers, eight assistants and a further six assistants stationed at Wanneroo. The number of professional officers engaged wholly in research throughout the Department was twelve. In the late 1970s research into fauna and jarrah dieback increased dramatically. Technical staff grew steadily in number to approximately 40 by 1980.

The first Chief of Research Division, Mr G E Brockway, was appointed in 1964. He was followed by Mr W H Eastman in 1966. Dr E R Hopkins was appointed to the position of Chief of Division in 1972. He remained in this office until 1978 when Mr J J Havel was appointed to the position. Mr Havel was in charge in 1985 when the Forests Department amalgamated with the wildlife section of the Department of Fisheries and Wildlife and the National Parks Authority. The growth in numbers of staff involved in forestry research until 1985 is summarized in Figure 1a.

Wildlife Research

Research into wildlife dates back to 1964 when a fauna research unit was set up within the Fisheries Department. A graduate from the University of Montana USA - T L Riggert - was the first Research Officer appointed. Research at this stage was primarily focused on a study of the wetlands of the coastal plain between Perth and Bunbury to determine their value to wild duck populations and to ascertain their role in maintaining those populations. Other research projects being pursued externally included the study of fauna reserves for the purpose of introducing proper management measures; the short-necked tortoise the habitat of which was restricted to a few areas in the Bullsbrook area; and the almost extinct Noisy Scrub Bird. Research on kangaroos commenced in 1967 with the appointment of a graduate cadet research officer and research on habitat management commenced in 1968.

In order to assist the administration of fauna conservation the State was divided into thirteen fauna districts in 1965. As funds became available wardens were stationed in each of the districts.

Staff numbers in research increased in 1968 when another Research Officer (Andrew Burbidge) was appointed along with two more technical officers. By the mid seventies seven full time Research Officers and ten technical staff were engaged wholly on wildlife research. At that time research in the Department was divided into biological survey work, macropods, estuarine wildlife, pesticides, wildlife, and waterfowl research and game management.

By 1971/72 it was realized that accommodation was inadequate and generally unsuitable for the specialized needs of the fauna research branch. The waterfowl research office was located at the Fisheries offices in Ellam Street, Victoria Park and the Reserve Management and Macropod research units were housed in temporary premises at 266 Hay Street, East Perth. As a result of this overcrowding 39 ha at Wanneroo, near Lake Joondalup, were acquired for the

establishment of a new research station to accommodate all areas of fauna research.

The Wildlife Research Centre was completed in August 1973 and officially opened on 6 March 1974 by His Royal Highness, Prince Phillip, Duke of Edinburgh. The Research Centre is situated in a nature reserve, but includes access roads and animal pens. The major part of the reserve is Banksia/Tuart woodland, which is of value to conservation as a sample of the vegetation that grows on the yellow sands towards the western side of the coastal plain.

In 1975 a two year study of the birdlife of the Peel Harvey estuaries was initiated and preliminary studies were carried out to provide background information for a long term fire ecology study.

Dr Riggert, whose work was mainly concentrated on waterfowl and wetland management, resigned during 1977. Work on waterfowl was subsequently taken over by Mr J A K Lane. The position of Research Officer (Flora) to assist in the management of flora in WA was established in 1977. 1976 saw the first of a planned series of plots for a detailed study of post-fire regeneration of vegetation establishment at Two People's Bay Nature Reserve. A preliminary survey of crocodiles in some rivers of the north-west Kimberley was set up during 1977-78. Observational data on Dugongs were also collected during 1977.

1978 saw the number of professional officers engaged in research increase from eight to ten. This was accompanied by an increase in technical staff from 11 to 13. In November 1980 a pilot project - "Atlas of the Western Australian Flora" was launched. Staff numbers declined in 1981 to eight professional and ten technical officers all based at the Wildlife Research Centre, Woodvale. This decline was primarily due to financial constraints

By the 1980s research had been systematically divided into the following sections - Biological Survey, Animal Ecology, Plant Ecology, and Flora Conservation. Staff numbers remained static until 1984 when two new positions - a Computer Systems Officer and a Computer Programmer were created. The growth in numbers of staff involved in fauna (wildlife) research until 1985 is summarized in Figure 1b.

Western Australian Herbarium

Western Australian plant collections dating from the 1890's were originally housed in herbaria within the WA Museum and Department of Agriculture. By 1916 the Forests Department had established a forest herbarium. In 1928 it was decided these three herbaria should be amalgamated to form a single State Herbarium within the Department of Agriculture. This was finally implemented in 1959 and the name changed to the Western Australian Herbarium in 1970. 1928 also saw the appointment of Mr C A Gardner to the position of Government Botanist and Curator of the State Herbarium.

Most of the early herbarium collection was housed in the Old Observatory Building. The collection was moved in 1959 to the Department of Agriculture's main office in South Perth. At this time Bob Royce took over the role of Curator. Royce remained in office until his retirement in 1974. John Green was subsequently appointed Curator in 1975 until his retirement at the end of 1987. In 1970 a specifically designed building was completed on land adjacent to the Department of Agriculture. The growth in numbers of staff at the WA Herbarium until 1988 is summarized in Figure 1c.

The Amalgamation

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 the first Director of Research and Planning.

On amalgamation the combined staff numbers of the newly formed Research Division were:

	Professional	Technical
Wildlife Research	14	13
Production & Protection Research	22	40
TOTAL	**36**	**53**

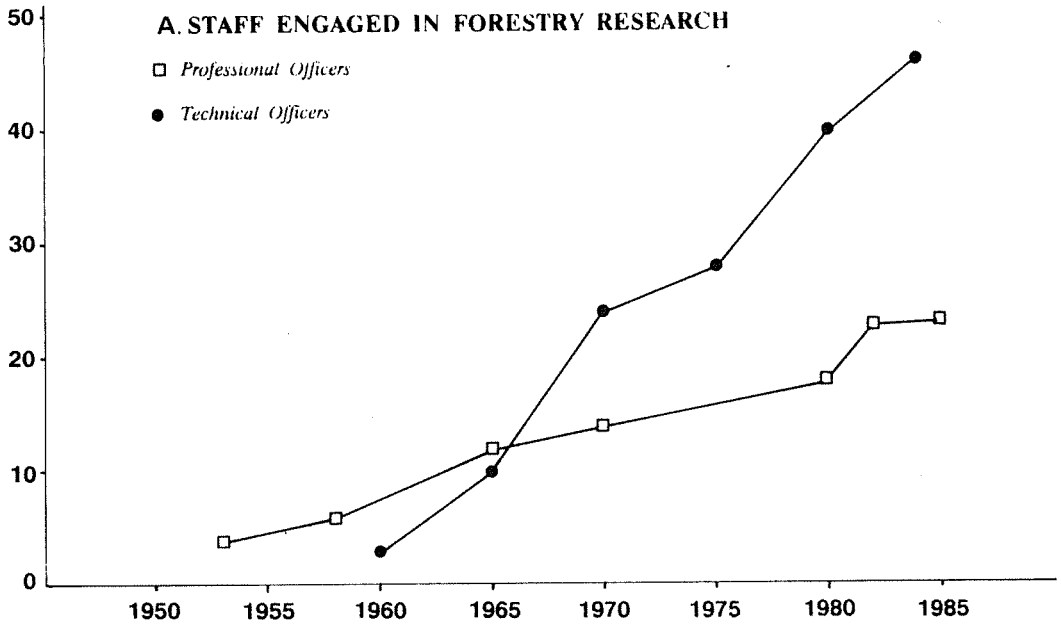
This new unit saw research staff located at five centres - Como, Woodvale, Dwellingup, Busselton and Manjimup. Research Scientists were also located in regional offices at Kalgoorlie and Karratha, and also in CALM offices at Narrogin, Bunbury and Wanneroo.

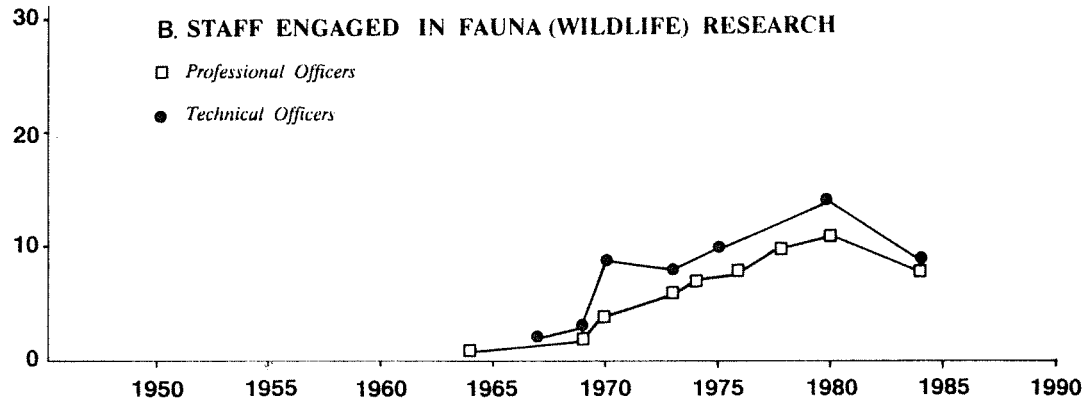
Dr Andrew Burbidge was appointed as Divisional Manager, Research in April 1987. At this time the Research Division was restructured and a 12 program structure was adopted consisting of Biogeography, Fauna Conservation, Fire, Flora Conservation, Jarrah Forest, Karri Forest, Pine, Plant Diseases and Pests, Rehabilitation, Wetlands and Waterbirds, Research Computing, and Executive and Administrative Support. This organization helped create better integration of the two research groups that came together with the formation of CALM.

The program structure was further reviewed in March 1988 (see Part 5) and in July 1988 the following final structure of research programs was adopted: 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.

The Division was further expanded in July 1988 when the Western 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 has been incorporated as a program in itself within the Research Division. This integration added an additional twelve professional officers and five technical officers to the Division.

The growth in numbers of staff involved in forestry research, wildlife research, and WA Herbarium research over the past 20-30 years is summarized in Figure 2.





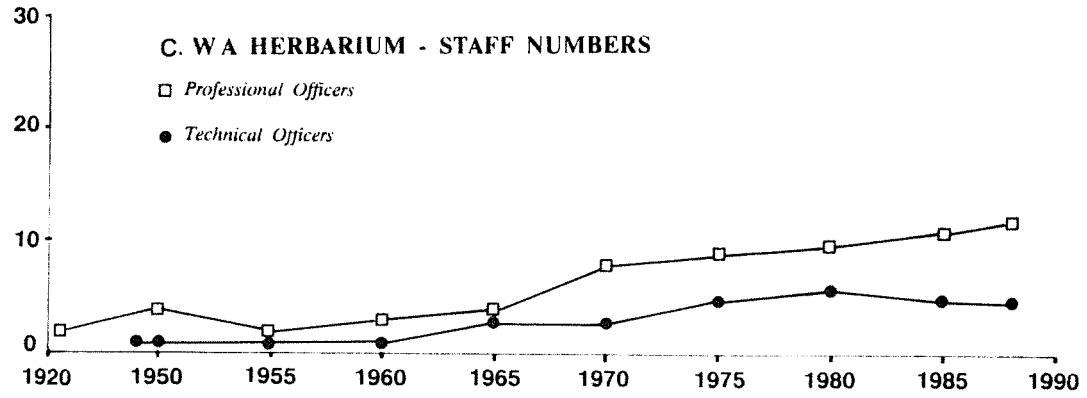


Figure 1
Staff engaged in Forestry Research, Fauna (wildlife) Research and at the WA Herbarium (based on all available information).

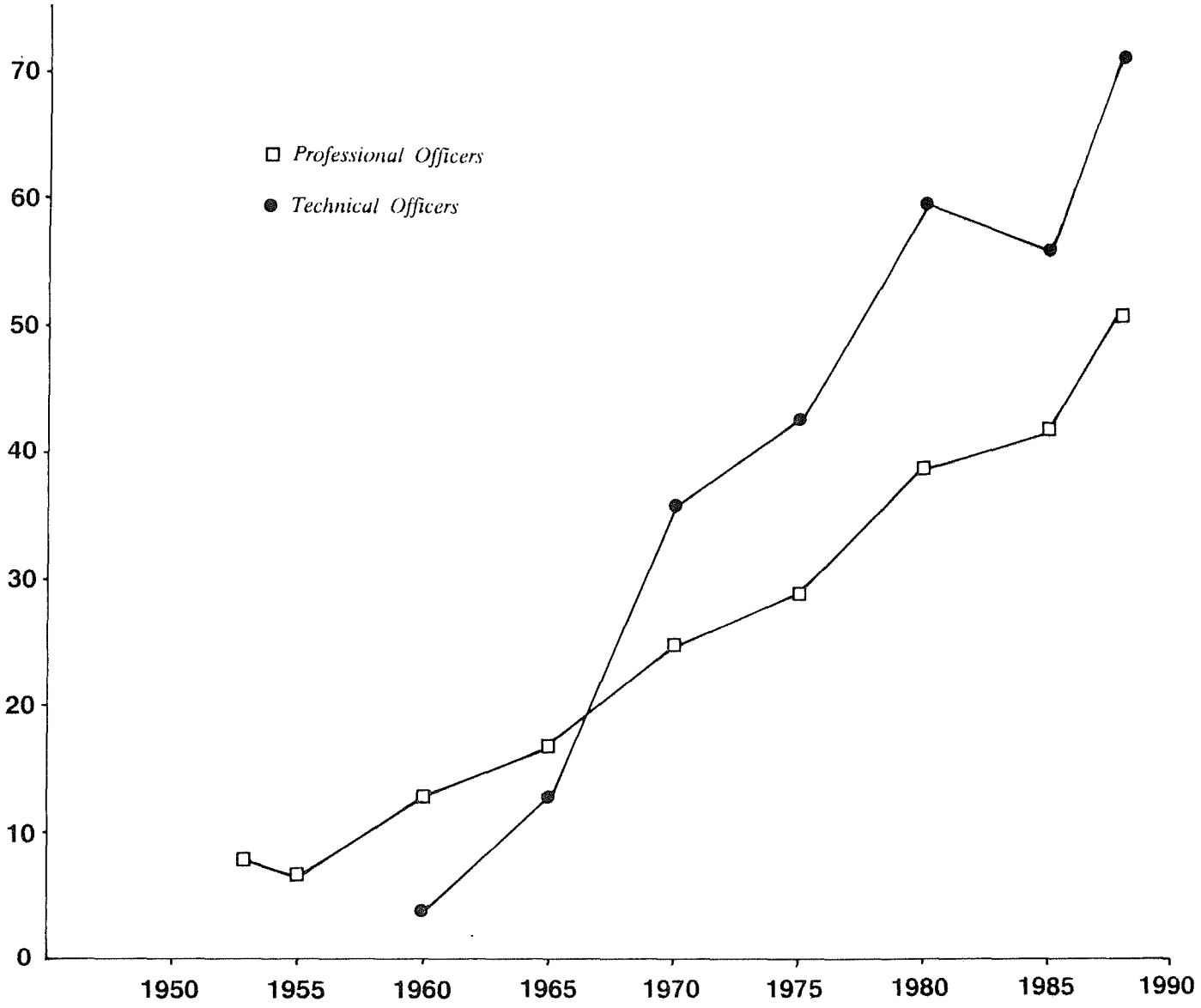


Figure 2
Growth in number of staff in Research Division over the past 30 - 40 years.
(Compiled from the data in Fig 1a - 1c).

PART 2 ORGANIZATION

The Division of Research is one of five Divisions in the Operations part of CALM under the overall control of the General Manager. The Division is led by the Divisional Manager, Research, and a corporate team consisting of two Senior Principal Research Scientists, two Principal Research Scientists and the Curator of the WA Herbarium (Table 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 and at two Regional Headquarters (Kalgoorlie, Karratha), which are administered by Woodvale. Some Como Research Centre staff are located at Narrogin and Wanneroo District Offices.

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 much for any one person in which to be proficient.

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.

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

DIVISIONAL MANAGER

Responsible for overall final decision-making and leadership of Research Division, chairing of RDPG meetings, and attending and contributing to Departmental Policy Directorate meetings.

SPRS/PRS (MANAGEMENT) TEAM

Responsible for management of staff; budget control; review of Environmental Review and Management Plans, CALM management plans and Guidelines for Necessary Operations; ensuring that the results of research projects are implemented; liaison with Regional, District and Branch managers; and review of research project proposals.

SPRS/PRS (SCIENCE) TEAM

Responsible for scientific matters, including review of manuscripts for policy matters; review of research project proposals; organization of seminars; publishing; revision of this research plan; review of programs; productivity; co-ordination of applications for research grants and preparation of Research Division's contribution to the Departmental Annual Report.

CURATOR OF HERBARIUM

Responsible for administration of the WA Herbarium.

PRS (SPECIAL PROJECTS)

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 are elected by members of the Program for a 3 year term. Their duties are as follows:

Coordinate research in the program and, in conjunction with SPRS/PRS (Science), maintain scientific standards.

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

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

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

Foster links between programs where appropriate.

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

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.

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

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

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

Seek opportunities for positive interaction with Managers in other Divisions.

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.

Table 1
Principal Officers of the Research Division

* *Acting*
***Co-opted as required*

Research Division Policy Group

Manager	A.A. Burbidge, *BSc(Hons)PhD(W.Aust)*
Senior Principal Research Scientist (Management)	P. Christensen, *BSc(Hons)(Rhodes)PhD(W.Aust)*
Senior Principal Research Scientist (Science)	S.D. Hopper, *BSc (Hons)PhD(W.Aust)*
Principal Research Scientist (Management)	A.N. Start, *BSc(Hons)PhD(Aberdeen)*
Principal Research Scientist (Science)	I. Abbott, *BSc(Hons)(Sydney)PhD(Monash)*
Curator, Western Australian Herbarium	B.R. Maslin, *BSc(Hons)MSc(W.Aus.)**
Principal Research Scientist (Special Projects)	J.R .Bartle, *BSc Agr(W.Aust)***

Program Leaders

Executive and Administrative Support	A.A. Burbidge, *BSc(Hons)PhD(W.Aust)*
Biogeography	N.L. McKenzie, *BScMSc(Monash)*
Entomology	I. Abbott, *BSc(Hons)(Sydney)PhD(Monash)*
Fauna Conservation	R.I.T. Prince, *BSc(Agr)(Hons)PhD(W.Aust)*
Fire	N.D. Burrrows, *BSc For(Aust.Nat.Univ)*
Flora Conservation	D.J. Coates *BSc Agr(Hons)PhD(W.Aust)*
Herbarium	B.R. Maslin, *BSc(Hons)MSc(W.Aust)**
Plant Diseases	B.L. Shearer, *BSc Agr(Hons)(W.Aust)PhD(Minnesota)*
Rehabilitation	J.R. Bartle, *BSc Agr(W.Aust)*
Research Computing	M.H.C. Choo, *BSc(Hons)MSc(Loughborough)*
Research Methods	D.J. Ward, *B.Appl.Sci(WAIT)*
Silviculture	J.F. McGrath, *BSc Agr(Hons)PhD(W.Aust)*
Wetlands & Waterbirds	J.A.K .Lane, *BSc(W.Aust)*
Wood Utilization	G.R. Siemon, *BSc For(Hons)PhD(Aust.Nat.Univ)*

Research Centre Managers

Como	J.F. McGrath, *BSc Agr(Hons)PhD(W.Aust)*
Dwellingup	B.L. Shearer, *BSc Agr(Hons)(W.Aust)PhD(Minnesota)*
Herbarium	B.R. Maslin, *BSc(Hons)MSc(W.Aust)**
Manjimup	W.L. McCaw, *B For Sc(Hons)(Melbourne)*
Woodvale	J.A.K. Lane, *BSc(W.Aust)*

PART 3 RESOURCES

In 1987/88 the Division comprised 47.8 Professional and 81.9 Technical and clerical staff, totalling 129.7 persons (full time equivalent). Some of these persons were casual or part-time. The equivalent data for 1986/87 are 37.25 + 70.65 = 107.9. The 1987/88 position represents a 20% increase in Research Staff. This was mainly due to the incorporation of the W.A. Herbarium in the Division.

The total CRF budget in 1987/88 was $5 726 163 consisting of $3 947 483 for salaries, $266 380 for wages and $1 512 300 for other costs (research, travel and plant). In 1986/87 the equivalent data were $4 544 289, $2 935 974, $313 015 and $1 295 300.

In 1987/88 Research Division accounted for 9.07% of staff positions and 6.66% of the Department's total budget. The corresponding figures for 1986/87 were 12% and 7.1%

Resources in 1987/88 are summarized for each Program in Tables 2 and 3. Wood Utilization is omitted as its budget is managed by the Division's Forest Resources through the Public Interest Project.

Table 2
Summary of Resources 1987/88 in Research Division (CRF)

Program	Prof Staff	Tech Cler Staff	No. People	% Staff	Salaries $	Wages $	Other $	Total $	Finance %
Executive & Administrative Support	5.15	16.5	21.65	16.76	614 945	67 375	234 232	916 552	1
Biogeography	3.65	3.6	7.25	5.60	248 612	5 930	112 605	367 147	6.41
Entomology	1.6	4.3	5.9	4.56	137 058	0	21 370	158 428	2.77
Fauna Conservation	4.4	4.7	9.1	7.05	321 211	8 000	182 515	511 726	8.94
Fire	5.35	10.45	15.8	12.23	491 429	3 605	142 835	637 869	11.14
Flora Conservation	1.55	2.15	3.7	2.86	130 751	0	63 710	194 461	3.4
Herbarium	10.7	5.0	15.7	12.15	606 547	21 000	186 980	814 527	14.22
Plant Diseases	2.3	8.9	11.2	8.66	321 009	53 700	98 838	473 547	8.27
Rehabilitation	2.95	3	5.95	4.60	191 101	10 200	37 615	238 916	4.17
Research Computing	2	1.6	3.6	2.79	111 769	0	145 310	257 079	4.49
Research Methods	2	0.5	2.5	1.94	59 459	0	17 650	77 109	1.35
Silviculture	4.45	19	23.45	18.16	583 158	96 570	202 830	882 558	15.41
Wetlands & Waterbirds	1.7	1.7	3.4	2.63	130 434	0	65 810	196 244	3.43
Research Division Total	47.8	81.9	129.2	100	3 947 483	266 380	1 512 300	5 726 163	100

Table 3
Summary of External Resources 1987/88 in Research Division

Program	Prof Staff	Tech Cler Staff	No. People	% Staff	Salaries $	Wages $	Other $	Total $	Finance %
Executive & Administrative Support	0	1	1	5.05	5 152	0	0	5 152	1.26
Biogeography	0	1	1	5.05	23 884	0	109 537	133 421	25.47
Fauna Conservation	0.5	1	1.5	7.57	42 245	0	50 700	92 945	20.88
Flora Conservation	2	0	2	10.10	35 975	0	5 099	41 074	9.23
Herbarium	1	1.5	2.5	12.63	47 900	0	0	47 900	10.76
Plant Diseases	1	1	2	10.10	55 648	0	0	55 648	12.51
Rehabilitation	5	4.8	9.8	49.50	69 120	0	0	69 120	15.62
External Total	9.5	9.8	19.8	100	279 924	0	165 336	445 260	95.73

PART 4 ALLOCATION OF PRIORITIES FOR RESEARCH

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 REVIEW OF PROGRAMS 1988

BACKGROUND

The Research Division Policy Group throughout the period 29 March 1988 to 26 April 1988 reviewed each of its ten research programs and also the Research Computing Program. The object of the exercise was to re-assess objectives and priorities of research and to ensure that any re-allocation of staff and finances among programs in the 1988-89 fiscal year would have a sound and equitable base. Changes made as a consequence of the review are incorporated in this revision of Research Division's rolling Five Year Plan.

STRUCTURE OF THE REVIEW

The procedure adopted for reviewing the research Programs was as follows:

1. Program Leaders arranged for a copy of their respective program (extracted from the Research Division Five Year Research Plan) to be circulated to the most relevant Operations staff within CALM and scientists outside CALM. This was accompanied by a questionnaire.

2. For each program two types of meeting were held:

   (a) Type 1 meeting - this was attended by all RDPG members, interested scientists and technical support staff and other interested CALM personnel. Personnel from outside organizations were also invited.

At this meeting the Program Leader summarized the program goals, activities and responses to the questionnaire. Each program member spoke on their research outlining:

- the priorities that guided the research
- the research that had been carried out
- benefits of the research
- essential components of the research
- possible consequences if the research was terminated
- future directions
- related non-research activities.

   (b) Type 2 meeting. This was attended by RDPG members, the relevant Program Leader and two invited guests from other divisions of CALM. At this meeting the Program Leader summarized the Type 1 meeting and results of the questionnaires. Consideration was also given to the confirmation of the priorities of the program, strategies adopted to achieve research objectives, new priorities and possible deletions.

3. A Type 3 meeting was convened to consider any re-allocation of resources/finances across all programs. This meeting was attended by RDPG members only.

The following summarizes the outcome of the above processes and was submitted for endorsement by the Policy Directorate. This met on 8 August 1988.

AIMS AND OBJECTIVES OF THE RESEARCH DIVISION

The overall mission statement of the Research Division is proposed as:

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

The overall objectives of the Division as resolved are appended (see Part 10)

RECOMMENDATION 1

The Policy Directorate endorse the revised aim and objectives of the Division.

ACTION

Adopted unchanged.

INTERACTIONS WITH OTHER DIVISIONS

Research Division has extensive positive interactions with other Divisions and with Policy Directors. It is expected that communication with other Divisions will continue to improve

now that the RDPG has filled its senior positions and allocated this as a major task of the SPRS and PRS (Management).

A high priority was reaffirmed to ensuring that research results are put into practice. While efficient mechanisms for this process exist through the cooperative assistance of branches in other divisions such as Silviculture, Environmental Protection, Fire Protection and Wildlife and Land Administration, problems exist in the wildlife conservation areas. For example, endangered species management has no professionally qualified service branch in Services Division. Similarly, routine monitoring of wetlands for, *inter alia*, the determination of duck hunting seasons, routine assessment of kangaroo harvest returns to determine quotas, of wildflower pickers' returns to control industry practices and routine flora and fauna inventory and monitoring of existing and proposed national parks, nature reserves, conservation parks, etc. are not covered by existing branches in other Divisions of the Department. Most Regions, particularly the more remote ones, lack adequate and suitably qualified staff able to carry out such functions. These activities are managed to varying degrees by Research Division staff, yet they clearly do not constitute research, and impair the Division's ability to respond to new research requirements.

RECOMMENDATION 2

That Policy Directorate initiates a workshop involving relevant staff to develop strategies for the creation of a Wildlife Management Branch or Division to provide professionally qualified assistance to regional operations in the fields of endangered species management, duck hunting, kangaroo harvesting, wildflower picking, flora and fauna inventory and monitoring.

ACTION

Adopted unchanged.

RESEARCH DIVISION BUDGET

Two matters need clarification.

1. Proportion of research funds spent on nature conservation and production.

Research Division is aware that funding must be related to performance. In silviculture and some other types of research and development, performance can be fairly easily assessed and the Division is happy to be funded according to its record. However, the benefits of nature conservation research are less easily quantified and it is proposed that such research expenditure be placed at least on parity with expenditure on research directed towards the maintenance of sustainable yield, the management of multiple use forests and the impacts of forest operations.

RECOMMENDATION 3

That Policy Directorate endorse the principle that an approximately equal division of resources occur between silviculture and other production-oriented research and nature conservation research for the next five years.

ACTION

Not adopted. This Recommendation was restated as: That Policy Directorate endorse the principle that there should be a balance of research work in all areas of Departmental responsibilities.

2. New Research funds

While the Division acknowledges that funding must be related to performance, it points out that performance is also dependent on funding. The Department is continually planning new initiatives and proposing significant growth in existing operations. The need for increased levels of research commensurate with the adoption of new intiatives is not always recognised.

Research Division believes that, particularly but not only in commercial areas, the Department should, like any efficient business, invest a proportion of the costs of new ventures in research and development to ensure the highest levels of efficiency and success to the outcome of those ventures.

One result of a lack of a policy to invest a portion of the costs of new ventures in research will be a declining proportion of Departmental CRF funds allocated to Research Division. Expenditure in 1987/88 was 7.3% of $65.9 million. The 1988/89 budget estimates included significant proposals for growth, some of which did not include a research component. While the

estimates reflect a potential growth that may not be realized and non-operational items such as increased loan repayments and workers compensation insurance premiums, it is clear that we are not including research allocations in all relevant initiatives. This does not reflect recent performance, reduces the scope to exploit good investment opportunities in research and inhibits the development of conservation. It is considered that an allocation of the order of 10% of the Departmental budget is an appropriate level for research and development and that when new initiatives are planned consideration should be given to including a standard 10% allocation for research.

RECOMMENDATION 4

That Policy Directorate recognize the need for allocating a proportion (approximately 10%) of new funds to research and development and that funding for Research Division be at least maintained at around 7.5% of the Department's budget with gradual growth to 10%.

ACTION

Not adopted. This Recommendation was restated as : That Policy Directorate recognize the need for allocating a proportion (approximately 10%) of new funds to research and development and that funding for Research Division be maintained at least at current levels.

PRIORITIES FOR NEW RESEARCH AND STAFF RESOURCES

Environmental weed research was identified as the first priority for new areas of research within the Division. Very little effort is currently expended on weed research and the importance of the problem has been overlooked. Pine silviculture research related to drought deaths and endangered flora and reserve surveys in the wheatbelt area were also assessed as having high priority on the new research listings. At present Research Division has three staff items on Policy Directorate's approved list for new positions - a Technical Officer for the Biogeography Program to replace the one lost in the 4% staff cut and a Research Scientist and Technical Officer for fire research. The Biogeography T.O. should remain, but the fire staff should be replaced with higher priority items.

A general lack of staff was identified across all programs. The finalizing of some projects will release some resources. Priorities for new research positions are indicated above but priorities within existing programs and the expertise of staff being released will dictate that most new work will be an extension of current research.

The Regional Manager, Central Forest Region, has offered to investigate the possibility of transferring one FTE from Central Forest Region Operations staff to Research Division for the creation of a position for a Pine Silviculturist. It is proposed that this research scientist will look into site classification and follow up work previously done on the death of pines through drought and that he/she be located at Busselton.

A review of staff allocated to administration and financial control in the Division showed clearly that clerical staff in most centres are overloaded. This is due in part to the Division accepting external funding with no administrative overheads component, partly to growth in research staff and partly to the item for the Divisional Manager's secretary being retained at Crawley. We can not continue to attract external grants on the basis that we will provide administrative backup unless we commit extra resources ourselves. Some granting organizations (e.g. ANPWS and WWFA) require CALM to show a 1:1 matching contribution but some do not. In future all grant applications should include allocations for administration where possible.

RECOMMENDATION 5

That a twelve month project be initiated to review the environmental weed problem. This is to be arranged with current resources.

ACTION

Adopted unchanged.

RECOMMENDATION 6

That Policy Directorate endorse the proposal for the creation of a Pine Silviculturist position and the transfer of an FTE from Operations Division for this purpose.

ACTION

Deferred for further consideration.

RECOMMENDATION 7

That Policy Directorate place two research scientists and two technical officers on their priority list for vacancies to conduct research on environmental weeds and on wheatbelt flora and fauna. The wheatbelt staff would be based in the Wheatbelt Region.

ACTION

Adopted unchanged.

RECOMMENDATION 8

That Policy Directorate endorse the Division's view that extra administrative staff are required in Research Centres and that this is partly achievable by ensuring that external grants include an amount to offset administrative costs.

ACTION

Adopted unchanged.

PROGRAM BOUNDARIES

The review process identified some overlaps across programs due largely to ill-defined program boundaries. The splitting of research scientists' time across a number of programs was seen as inefficient. It was agreed that some programs be amalgamated and new ones created. Marine research will commence as a small unit attached to RDPG until such time as it grows to the minimum size of a Program.

RECOMMENDATION 9

That the programs be restructured as follows:

(i) *Research Programs*
Biogeography
Entomology
Fauna Conservation
Fire
Flora Conservation
Herbarium (boundaries to be reviewed at a later date)
Plant Diseases
Rehabilitation
Silviculture
Wetlands and Waterbirds
Wood Utilization

(ii) *Service Programs*
Executive and Administrative Support
Research Computing
Research Methods

ACTION

Adopted unchanged

Biogeography Program

Research that provides data for (i) land use decisions, including the acquisition of land, and (ii) selecting priorities among the Department's wildlife management and research needs were seen as the most important functions of the program. In recent years the program has taken on new projects before finalizing old ones. The current workload and the array of projects that need to be undertaken by the program is too big to be handled efficiently by the staff available.

Managers, especially those from the Regions outside the south west, are constantly requesting information on land they are managing. Many surveys are routine and could be done if suitably qualified and trained staff were based in the Regions.

RECOMMENDATION 10

That effort in the Biogeography Program during the next two years be concentrated on writing up the current backlog of work, especially the Eastern Goldfields district survey, the Rainforest Survey and the Buccaneer Archipelago survey. Field work on the next district survey (Irwin/Carnarvon) should not commence until 1989/90. All completed work to be written up by 30 June 1990.

ACTION

Adopted unchanged

RECOMMENDATION 11

That consideration be given to including new regional survey staff (based in the regions) in the proposed Wildlife Management Branch or Division. (See also Recommendations 2 and 7).

ACTION

Adopted unchanged

Fauna Conservation Program

Research into endangered species was considered to be the focal point of the program over the next five years. Invertebrate research was considered too big an area to tackle with current resources. The Program needs to clarify its future directions.

RECOMMENDATION 12

That target dates be set for the research component of Numbat project and the Dugong and Marine Turtles projects to be finalized and applied. These officers to pick up other areas of research as detailed in the revised Research Plan after the Program has met to form a strategy on future directions.

ACTION

Adopted unchanged

Flora Conservation Program

Due to staff reductions in the program it is necessary that a significant portion of the program be deleted - this will be reflected in the re-written Research Plan.

RECOMMENDATION 13

That the recent depletion in staff of the small Flora Conservation Program be redressed as a priority. (This may occur through the appointment of a permanent team to research wheatbelt flora as proposed under Recommendation 7 and through utilization of Herbarium resources).

ACTION

Adopted unchanged

Jarrah Forest, Karri Forest and Pine Programs

Due to considerable areas of common interest within these programs it is considered necessary that they be amalgamated and operate as one program. Additionally, Wood Utilization should be recognized as a separate Program.

RECOMMENDATION 14

That the Jarrah Forest, Karri Forest and Pine Programs be amalgamated and renamed the Silviculture Program, and that Wood Utilization should become a separate program. Components of the former programs that better fit programs such as Fauna Conservation and Fire will be transferred to the appropriate program.

ACTION

Adopted unchanged

Plant Diseases and Pests Program

This program has been renamed the Plant Diseases Program. The Pests component will be transferred to the new Entomology Program. A redirection of some resources from jarrah forest dieback research to dieback in south coast communities is proposed for the program. A need for coordinating dieback work throughout the Department was identified.

RECOMMENDATION 15

That Policy Directorate endorse the principle that an equal division or resources occur in the Plant Diseases Program between dieback research in the jarrah forest and research in conservation reserves.

ACTION

Adopted unchanged

Rehabilitation Program

Few problems were seen with this program as it currently stands. It is desirable, however,, that priority be given for some work outside of the south west of the State, but lack of resources inhibits this at present. *Eucalyptus globulus* research will, in time, fall into the proposed Silviculture Program. Tree establishment research in farmland in Narrogin will be wound down in favour of research focussing on retaining and sustaining remnant patches of native vegetation in the wheatbelt. Agroforestry research will be part of this program.

Fire Program & Wetlands and Waterbirds Program

Both the Wetland and Waterbirds Program and the Fire Program are currently running effectively and the review process did not highlight any areas where major changes should be made.

Research Computing and Research Methods Programs

Biometrics and modelling was identified as a separate program to the Research Computing Program and is identified as such within this edition of the Research Plan under the heading of Research Methods.

The aims of each of the above programs were addressed and revised where appropriate. They are set out in Part 11.

PART 6 ALLOCATION OF RESOURCES

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 Divisional Manager 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 (See Part 5). 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 Manager of Research Division. Members may come from Research Division, from the Policy Directorate, other Divisions or from outside the Department, as appropriate.

The order in which Programs will be reviewed, using the criteria laid down in Part 4 of this Plan, will be published in the next revision of the 5 year Plan.

NEED FOR ADDITIONAL RESOURCES

The proportion of CALM's budget allocated to scientific research needs to be higher than most other Departments for the following reasons:

Scientifically collected and validated information is crucial to the successful conservation of species and management of land in W.A.

The management of naturally occurring biological resources is extremely complex. Most of the time the Department is attempting to manipulate natural, slightly modified or degenerating ecosystems. It needs cost effective techniques to achieve certain aims and it needs to know what all the results of manipulating certain ecosystem components will be. Most of the time both the techniques and the information on effects are not available and must be developed locally.

The science of ecology is a comparatively new one and ecological theory is not well established. Studies that may have taken place in Europe or north America are usually not directly applicable to local situations. Even eastern States research is often not applicable

to W.A. problems, because of different local species, climate and geomorphology.

Western Australia is the only State to include all three major Australian biogeographic regions and it has an extremely rich flora and fauna. For example, there are more than 6 000 species of vascular plants in the south west and more than 80% of these occur nowhere else. Species richness in one locality can also be very high. Small samples of kwongan (heath) have plant species richness equal to or higher than equivalent areas of tropical rainforests, previously thought to be the richest terrestrial ecosystems in the world.

Partly because of the large number of taxa, W.A. has more endangered species of both plants and animals than any other State. We also have major environmental problems that must be combatted if we are to meet the aims of the State Conservation Strategy and maintain the richness of our biological resources, including the problems posed by introduced animals like the fox, introduced weeds like the blackberry and introduced diseases like the root rot fungus *Phytophthora cinnamomi*, as well as problems caused by changing land use such as increasing salinity and different fire regimes.

Forest based industries are a major component of the State's economy and are significant employers in the south west. These industries include the supply of timber and various wood products, water supply and mining for bauxite, coal, gold and tin/tantalite. These industries have a major impact on the forest and have the scope to interact adversely with dieback and salinity problems. The Department has a central role in integrating both planning and management to achieve efficient production while still maximizing protection of other forest values such as nature conservation and recreation.

It is not possible to get much relevant research carried out by other organizations. Most University research is short term and laboratory, rather than field, oriented, and most research carried out by CSIRO is industry oriented.

For these reasons the Department must maintain a high level of commitment to research. At present about 7% of the Department's total budget is spent by the Research Division. Research resources in nature conservation research were strengthened at the time the Department was created, but not nearly to the extent recommended in the 1984 report by the Task Force on Land Resource Management in Western Australia. To obtain the necessary scientific information for conservation of species and management of land, we need at least to hold our present commitment to research and at best improve it steadily to about 12% of staff and finance.

Some of the shortcomings in research are:

Pine silviculture is being inadequately serviced; in particular the pine share farming scheme at Albany is not receiving sufficient support and the lack of suitable growth data on pine stands greater than 10 years old is hampering the development of a growth model. Better definition of the potential for salinity control by pine share farming schemes is also needed.

At a time when there is increasing operations in the jarrah forest there is a contraction of silvicultural research in the area. In particular, there is a need for more fundamental research on jarrah regeneration and intensive silviculture. Studies are also needed on marri, a species of increasing economic and conservation importance. Additional studies are required on the impact of new forest operations.

Tree establishment on farms, especially for salinity control purposes but also for other reasons such as timber and firewood production, windbreaks, etc., needs greater research input. CALM's input in this area is very small in comparison to the magnitude of the problem and the increasing interest and requirements of farmers. Management of woodlots or remnants of native vegetation on farms is a major problem which, if not addressed, has a capacity to alter the character of south west rural areas.

More research effort is needed on leaf defoliating insects, in particular Jarrah Leafminer and Gumleaf Skeletonizer. Defoliation of Flat-topped Yate on the South Coast is of concern to farmers and conservationists in the lower Great Southern. Defoliation and death of several species of tree by Bag-shelter caterpillars in the Greenough

and Wheatbelt regions is also disquieting. We do not know why these major insect problems have emerged in recent years in forests and woodlands.

There is no standard system of monitoring change in major ecosystems and relating those changes to either natural events or cycles, or to human-induced disturbances.

Too little work has been carried out on the conservation of plant species in the past, especially in comparison to vertebrate animals and in view of the fact that W.A. has about 50% of the nation's threatened plants. At present we lack much of the basic data on distribution and abundance that is necessary before overall priorities can be be shifted significantly to studying processes such as pollination ecology, recruitment after fire, the impact of dieback and the effects of commercial wildflower picking and beekeeping.

Little is known about the conservation of invertebrate animals in W.A. The very large number of undescribed species and the difficulties of sampling invertebrates are probably responsible for their neglect.

A large number of Wildlife Management Programs need to be prepared for endangered species of both plants and animals. The large number of endangered plants in W.A. is mentioned above. In the case of animals a recent review of mammal conservation concluded that W.A. has 9 of a total of 16 endangered species that are restricted to the Australian mainland, as well as 5 out of 6 species that are now extinct on the mainland but remain on islands.

There is little work being carried out on the effects of environmental weeds or introduced herbivores on CALM land.

The Department has assumed new responsibilities not previously undertaken by the amalgamating organizations and has commenced new tasks not attempted before. Additionally, new initiatives are being implemented, often because of public pressure. Some of the above are:

Responsibility for marine parks and marine nature reserves.

The pine share farming scheme.

Freshwater stream ecology in relation to the woodchip licence area.

Control of *Phytophthora cinnamomi* and allied species in south coast and other national parks and nature reserves.

Trees on farms in agricultural areas.

More intensive silviculture in the Darling Range.

Problems with insect damage in the jarrah forest.

Management of land in remote areas, such as the Kimberley, Pilbara and the deserts.

Greater involvement in the conservation of endangered species.

In all of these areas research is needed to ensure that decisions and management procedures are correct and cost effective.

External funding for research will be sought where possible. In particular the Research Division will:

Investigate the creation of Research Trust Funds that will attract external funds subject to 150% tax deductibility.

Investigate the establishment of research stations in various parts of the State, funded partly from Government and partly from external sources, that will attract research workers from overseas. The first areas to be investigated will be the Great Victoria Desert, the north Kimberley (Prince Regent Nature Reserve) and the Pilbara.

Arrange for experienced scientists, especially from overseas, to work at the Department's Research Centres and Stations while on study leave or as Visiting Scientists. This will include retired scientists who wish to continue research part time at their own expense or with minimal assistance from the Department.

Continue to seek Commonwealth research funding within the framework laid down by relevant Commonwealth authorities.

Success in attracting extra external funds will not lead to a reduction in the level of Departmental funding for research.

PART 7 GEOGRAPHICAL DISTRIBUTION OF RESEARCH EFFORT

Research effort is spread throughout the State. Table 4 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 4, as they are service programs.

Table 4
Geographical Distribution of Research by Programs 1987/88

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
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	-	-	-	-	-	-	-	30.0	37.0	33.0	-	-
WOOD UTILIZATION	4.5	-	4.0	0.5	20.0	8.0	12.0	25.0	10.0	8.0	8.0	-

PART 8 STAFFING

PROFESSIONAL STAFF

Criteria for progression for research scientists up to level 6 exist and are being revised. Criteria for progression from level 6 to level 7, and from level 7 to level 8 are being developed. These will then need to be considered by the Public Service Commission.

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.

The ideal ratio of Technical Staff to Research Scientists is 2:1 and a ratio of 1:1 is essential for Research to be conducted effectively.

The SPRS/PRS (management) are responsible for development of career structures and training for Technical staff. Their aims, objectives and goals are detailed in Part 11, under the Executive and Administrative Support Program.

Criteria for progression of technical support staff from level 1 to level 4 are being revised.

ADMINISTRATIVE SUPPORT STAFF

RDPG have developed proposals for improving the organization of these 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, Kalgoorlie, Karratha, Wanneroo) and RDPG.

Division

No administrative officers have formally been appointed to oversee administrative matters at a Divisional Level. With the increased size of the Division since amalgamation, this situation needs to be reviewed. Clearly the integration of administrative financial management and reporting is critical to the administration of the Division. As an interim measure the Administrative Officer at Woodvale has been requested to oversee financial management at this level.

RDPG considers that a position at level 4 should be created for a Divisional Administrative Officer which should be filled by appointment.

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. Administative 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 O.I.C. Administrative Officer L3, one Clerk Typist (RDPG) and 1 Clerk Typist (Divisional Manager).

In summary, the total Staff Requirements (for present Research Stations and Division requirements) are:

L4	1 Divisional Administrative Officer
L3	3 Administrative Officers
L2	3 Assistant Administrative Officers
L2	3 Assistant Administrative Officers/Typists
L1	11 Clerk/Typist (assuming 2 each at Como and Woodvale)

The overall structure can be represented as follows (Fig. 3):

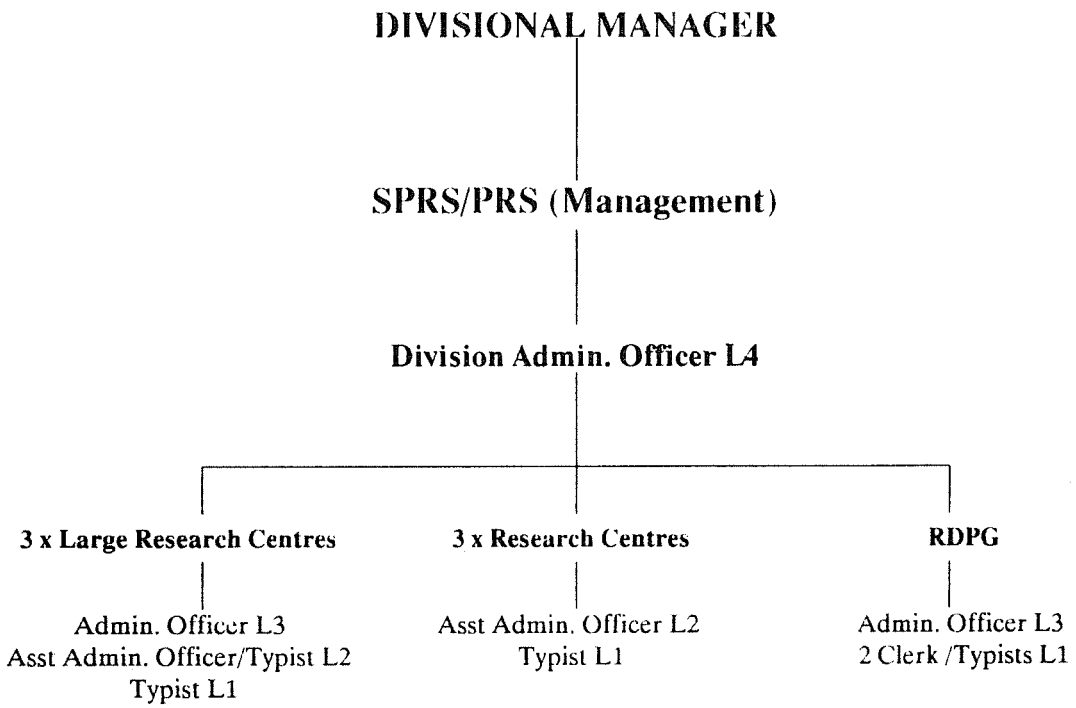


FIG 3.
PROPOSED ADMINISTRATIVE SUPPORT STRUCTURE IN RESEARCH DIVISION

PART 9 LOCATION OF RESEARCH STAFF AND BUILDINGS

INTRODUCTION

When CALM was formed it inherited research buildings placed according to the policies of its predecessors. Now that the Department has reorganized its research structure and priorities, it is appropriate to review the location of its research buildings, especially which ones should be extended and which ones might be phased out. Recently, also, there have been proposals to rationalize the Department's Perth buildings and this also indicates that a review of the location of research staff should take place.

The terminology used by Research Division for research buildings is:

Research Centre: A building housing research scientists and technical staff on a permanent basis. These staff may work primarily in the District or Region in which the centre is located or they may work State-wide.

Research Station: A building used by research scientists and/or technical staff on a temporary basis. Usually a research station is located in an area remote from a regional centre, often in a national park or nature reserve.

METROPOLITAN AREA

Current Situation

At present the Department has three research centres in the metropolitan region. In addition 4 technical staff attached to Como Research Centre are based at Wanneroo, close to their work on pine silviculture. The centres are:

Como Research Centre. This Centre is adjacent to State Operations Headquarters at Hayman Rd, Kensington, but the name "Como" is traditional. The Centre currently houses 23 full-time and 2 contract and up to 5 temporary staff. The building is overcrowded, some of the facilities are substandard, and some staff are housed in inadequate transportable and other temporary accommodation. Plans to extend the centre have been prepared and funds sought, but these have not been forthcoming. Security is provided by the SOHQ caretaker.

The Western Australian Herbarium. This Centre is located at George St, Kensington, at the southern end of the Department of Agriculture complex, about 1km from SOHQ. The Centre currently houses about 20 permanent and up to 5 temporary staff. While Herbarium staff have requested extensions to the building, this has not been supported in the past by the Department of Agriculture. The building is at capacity as far as the flora collections are concerned and there is little room for additional staff. Security is provided by the Department of Agriculture.

The Western Australian Wildlife Research Centre. This Centre is located at Ocean Reef Rd, Woodvale, about 33 km from both SOHQ and Crawley Head Office. It is situated within the 39 ha Woodvale Nature Reserve. The Centre currently houses about 40 full-time, 2 part-time and 3 contract staff and up to 10 temporary staff. The centre is at capacity and when approved transfers and appointments have been completed it will be overcrowded. Plans to extend the building to house an additional 8 permanent staff have been submitted but funding has not been approved. Security is provided by a resident ranger.

Future of Metropolitan Research Centres

It would be more efficient to have a single metropolitan research centre. This would lead to better communication between scientists, better sharing of expensive equipment, reduced travel time and costs, and reduced administrative costs and overheads. There are four options for reducing the number of centres:

Option A. Move Woodvale to Como Research Centre.

Advantages

Improved communication by Woodvale staff with Como research staff, SOHQ staff and the Herbarium.

Lower metropolitan travel costs.
Closer to southern research centres. Additional travel time for staff from Busselton,Dwellingup and Manjimup to Woodvale would be avoided.

Closer to Universities, Museum.

CALM's library could be transferred to SOHQ without problems.

Disadvantages

A $3 to $4 million (replacement cost) research centre at Woodvale would become vacant, with an uncertain future use.

The Department may find it difficult to justify keeping the Woodvale Nature Reserve - the land will become increasingly commercially valuable as the northern corridor grows.

Many Woodvale staff live in the northern suburbs and will not welcome a move of workplace south of the river.

Option B. Move Como Research to Woodvale.

Advantages

Improved communication between Woodvale and Como research staff.

Retains Woodvale buildings; Como buildings can easily be used for SOHQ staff.

Decentralizes Government activity away from city.

Disadvantages

Over 30 km from SOHQ, increases travel time and costs (for some staff), reduces efficient communication with SOHQ staff.

Further from southern research centres, Herbarium, Museum, Universities.

Woodvale is situated in bush and the fire risk is increasing with urbanization of surrounding area.

Many Como staff live south of the river and would not welcome a move so far north of the river.

Option C. Relocate the Herbarium to either Woodvale or the SOHQ site.

Advantages

Better communication between Herbarium staff and other researchers.

Reduced administration overheads.

Disadvantages

The existing Herbarium building is highly specialized and unlikely to be of value to other users.

If located at Woodvale, same disadvantages as Option B, plus problems with access by public to the Herbarium.

Option D. Relocate both Woodvale and Como Research to Herbarium site.

Advantages

All CALM metropolitan staff together, better communication and reduced administrative overheads.

Herbarium building retained (collection storage would still need extending).

Como research staff would get a new, better building.

Disadvantages

For Woodvale, same as Option A.

Synthesis

Clearly, if the Department did not have any pre-existing metropolitan research centre, it would choose Option D, and build a new research centre on the vacant land between the Herbarium and SOHQ. This option should, therefore, be carefully investigated. However, given the present situation, no simple solution is available that will meet all objectives and satisfy all people. Economic realities will probably dictate a solution that maximizes use of existing buildings. If so, then the Como Research buildings are most easily adapted to another use and it would be most logical to move these staff to a new site. There would be little point moving these staff to a new building adjacent to the

Herbarium unless it was also intended to move the Woodvale staff there at some future time.

These options will be carefully considered during the next year.

COUNTRY RESEARCH CENTRES

Country Research Centres have a number of advantages to CALM. First among these is the increased efficiency of staff working close to their study sites and the close working relationships that develop with regional staff. Small groups of research staff working at a regional or district centre, especially in remote areas, can, however, be an inefficient use of resources because:

One or two, often inexperienced, scientists working away from senior and peer scientists do not get the benefit of the frequent supervision and interaction vital to the efficient conduct of research.

Facilities at country centres with few research staff are usually poor.

Access to libraries, computer and statistics professionals, and other specialist support is poor.

Minimum staffing levels for Research Centres should be: 3 Research Scientists, 3 Technical Officers, 1 Computing Officer, 1 Administrative Officer and 1 Clerk Typist, a total of 9 persons.

Current Situation

At present Research Division has staff in the following country centres:

Busselton - 1 Research Scientist, 2 Technical Staff, 3 wages staff. Although we call this group the Busselton Research Centre they actuallly occupy part of the Busselton District Office and have no special research facilities.

Dwellingup - 3 Research Scientists, 13 Technical Staff, 2 contract staff. This group occupies the Dwellingup Research Centre, a loose collection of six buildings, only two of which are basically sound structures (and even these have safety problems). The remainder are transportable units and slightly upgraded shade houses.

Collie - 1 Research Scientist, 1 Technical Officer, both contract staff. These temporary staff are accommodated at the WA Water Authority offices.

Kalgoorlie - 1 Research Scientist, 1 Technical Officer. These staff occupy space in the badly overcrowded and poorly designed Regional HQ. They have no laboratory space or special facilities.

Karratha - 1 Research Scientist, 0 Technical staff (there is a proposal to transfer a Technical Officer from the south west at some future date). The RS occupies an office in the Regional HQ and has inadequate laboratory facilities.

Manjimup - 5 Research Scientists, 15 Technical staff. The Manjimup Research Centre is a well designed and constructed building with good facilities and is not overcrowded.

Narrogin - 1 Research Scientist, 1 Technical Officer, 1 contract staff. These people occupy space in the Department of Agriculture office. They have limited laboratory space. Plans have been made to house these staff in a new Regional Headquarters.

Future of Country Research Centres

BUSSELTON

The Busselton research group was set up primarily to study pine establishment and silviculture in the Donnebrook Sunklands. There is now no new plantings of pines in the Sunklands because of a change in Government policy and the group are tending to work further and further from their base. The Centre will remain as an outstation of Como Research Centre.

COLLIE

The temporary staff that are based at Collie are working on a specific problem in the Wellington River catchment and the study is not expected to extend beyond 1992. There is no justification for basing research staff permanently at Collie, since the area can be adequately serviced by staff from Manjimup or Dwellingup.

DWELLINGUP

The Dwellingup Research Centre has been considerably reduced in staff numbers in recent years. Furthermore the buildings are inadequate and have developed on an *ad hoc* basis. Clearly the future of the centre needs careful consideration. There are two options: retain and upgrade or abandon the centre and transfer the staff to Perth. If the latter course were followed the centre could become a research station.

Option A. Retain

Advantages

The centre is located in the jarrah forest, an area of continuing high priority research. It is close to Lane Poole Reserve, bauxite mines, water catchments and areas of high *Phytophthora* infection.

The centre is relatively close to Perth and staff can travel to and from Perth and conduct business in a day.

Disadvantages

Dwellingup is not a CALM regional centre. The town is small and declining and facilities are poor.

The research centre buildings are poor quality and need to be demolished and rebuilt.

Few staff want to live in or be be located in Dwellingup.

Option B. Abandon as centre, transfer most staff to Perth, retain as research station

Advantages

Staff centralized, better access to SOHQ and other metropolitan facilities.

Reduces Departmental housing problems, transfer costs, transfer problems.

Disadvantages

Centralizes research too much, already strong bias to Perth-based staff.

Reduces contact between research and regional and district staff.

Increased travel time and costs for work in the jarrah forest.

No space in Perth centres at present.

Research Division believes that, on balance, Option A should be followed, i.e. the values of having Dwellingup as a Research Centre outweigh the problems. However, if this option is to be followed a commitment needs to be made to build a new research centre and maintain staff numbers at a viable number. The staff at Dwellingup have produced a Building Plan that makes comprehensive recommendations concerning the upgrading of the buildings.

MANJIMUP

The Manjimup Research Centre is a viable, well housed group and should be maintained. There is space to transfer more staff to the centre if such transfers are indicated.

NARROGIN

Research Division sees the Wheatbelt as a high priority growth area for research staff. Narrogin-based staff have the benefits of working close to their study sites and within the rural community that the research is directed towards. Also, Narrogin is not too far from Perth to prevent reasonably frequent business trips. The problems of a small group of researchers at Narrogin are not as great as they are at Kalgoorlie or Karratha and under the circumstances is seems wise to maintain the *status quo* with the proviso that adequate facilities are provided for existing plus two additional staff when the new regional HQ is built.

ADDITIONAL COUNTRY RESEARCH CENTRES

Considerable pressure is exerted by regional and other staff from time-to-time for Research Division to base staff in other country centres. Places frequently mentioned include Albany and Kununurra.

Because of the difficulties small research groups pose, the Division will not agree to more than

one or two Research Scientist groups being set up in additional towns. Rather, we believe that we should consolidate our existing under-endowed centres and work to a plan to create new, viable groups as resources become available.

REMOTE COUNTRY RESEARCH CENTRES

Background

There are major issues requiring research in the remote regions. Recognition of these research needs has grown within the Department since its formation. Although Research Scientists from Woodvale have addressed some issues for many years, cost and logistical impediments have constrained the level of research being undertaken.

The Policy Directorate, recognizing the needs of research and the difficulty of conducting research in the remote regions from Perth bases, adopted the principal that Research Centres should be established in those areas and nominated Karratha as the first to be established. No timetable was set because the developments would require funding and personnel, neither of which were available at the time.

Research Requirements of Remote Areas

Two biogeographical Regions intrude into W.A., besides the Mediterranean south-west. They are the Torresian (most of the CALM Kimberley region) and the Eremaean or Arid (part Kimberley, most Goldfields and all Pilbara and Gascoyne CALM Regions).

The research needs of each of these zones on a Research Program basis is assessed in Table 5.

TABLE 5
ASSESSMENT OF RESEARCH NEEDS OF THE EREMAEAN AND TORRESIAN BIOGEOGRAPHIC ZONES IN WESTERN AUSTRALIA.

A score of 1, 2, or 3 has been given as follows:
1 = Relatively minor or irrelevant. Would probably not be addressed by a small research centre.
2 = Significant but not major problem OR reasonable knowledge exists.
3 = Major problem requiring research input if management is to be effective.

Program	Eremaean Zone (approx 80% of WA)		Torresian Zone (approx 10% of WA)	
Biogeography	Very little co-ordinated work. No good overview. Reserve System inadequate.	3	Moderate to good information. Reasonable overview. Existing and proposed Reserve System is reasonable.	2
Fire	Very little work. Major problems	3	Very little work. Major Problems	3
Fauna	Major problems. Many relict, vulnerable spp.	3	Many problems but fauna is mostly intact.	2
Flora	Extent of problem unknown. Many poorly known spp; about 7 DRF spp.	2	Extent of problem unknown. Many poorly known spp; 2 DRF spp.	2
Herbarium	Flora not started.	3	Flora being written.	2
No of "3" scores		4		1
TOTAL Score		14		11

In these regions of WA remaining programs are either irrelevant or of relatively minor significance to the forceable research requirements from this Division and would not receive priority from a small research centre. They would each score one for both zones.

Conclusion

While the total scores are not very different, the Eremaean Zone scored the maximum of 3 in four of the five programs used whereas the Torresian Zone scored the maximum of 3 in only one of the five programs. This indicates an overall more serious situation in the Arid Zone.

In the Eremaean Zone, both Karratha and Kalgoorlie are considered as possible locations. Kununurra is the only town considered for the Torresian. Advantages and disadvantages for each are considered under three broad headings covering accessibility to study areas, infrastructure and social qualities (the latter is important in attracting staff).

Proximity To Areas Requiring Research.

KARRATHA

Advantages

The best location for access to the Pilbara, Northern Deserts and Gascoyne areas (accessibility to SW Kimberley is on a par with Kununurra and to Gibson Desert with Kalgoorlie).

Research requirements in the Eremaean are more pressing than in the Torresian.

Proximity to the ocean would facilitate marine research.

Disadvantages

Torresian north and east Kimberley, Tanami Desert and southern deserts including Nullarbor are relatively inaccessible.

Research requirements in those areas could not be addressed from Karratha.

KALGOORLIE

Advantages

The best location for access to the Goldfields and southern deserts including the Nullarbor.

Research requirements in much of that area are more pressing than in the north and east Kimberley.

Disadvantages

Much of the Gascoyne, the Pilbara, the northern and western deserts and the Kimberley are no more accessible than from Perth.

Research requirements in much of those areas could not be addressed from Kalgoorlie.

Areas more accessible to Kalgoorlie than the other towns are relatively easily accessible from Perth where facilities are good.

KUNUNURRA

Advantages

The best option for access to the Kimberley and the northern deserts, particularly the Tanami.

There are pressing needs for research in those areas; the former is believed the only area in WA with an intact fauna and flora.

Disadvantages

Besides the Tanami and arid south Kimberley, access to the Arid Zone is not practical. Most of the more pressing needs for research there could not be addressed from Kununurra.

Conclusion

Karratha provides access to the widest range of areas in which research requirements are great. It should be remembered that the proposed Prince Regent Research Station will enhance opportunity for research in the north Kimberley.

Support Infrastructure

KARRATHA

Advantages

Housing. Although GEHA housing has been hard to obtain, winding down of the construction phase of the Woodside LNG plant may make housing available to the Government.

Herbarium. There is a small but good herbarium in Karratha.

Library. The college/community library is excellent and managed by a professional Librarian. All normal library facilities are available.

College. Karratha College provides an academic focus for the community. The Science Department has many facilities which could be accessed by a research team.

The principal industries employ scientists including Environmental Officers and Biologists. There is thus a scientific community in the town.

The Region is making available an FTE for a Research Scientist.

Disadvantages

Housing may still be hard to acquire.

KALGOORLIE

Advantages

There is a College which provides an academic focus for the community but it is primarily orientated towards mining and community programs.

There is a good library service.

Disadvantage

GEHA housing is very difficult to obtain.

KUNUNURRA

Advantages

The Department of Agriculture has a research station which provides a scientific community and could provide useful facilities.

Disadvantage

GEHA housing is very difficult to obtain.

There is no tertiary institution.

Conclusion

Karratha offers the best range of support infrastructure.

Social Environment

KARRATHA

Advantages

Karratha has the best schooling, shopping, sporting and other cultural and recreational facilities of the three towns.

Disadvantages

The climate is very hot during summer.

Besides the coast and offshore islands, (boat needed for access) the surrounding country is relatively unsuitable for natural area recreational pursuits.

Karratha is relatively remote from the metropolitan area

KALGOORLIE

Advantages

Educational, recreational and cultural facilities are reasonable in the town.

Kalgoorlie is within a day's drive of the metropolitan area.

Disadvantages

Summer can be very hot and winter very cold.

The surrounding country is not conducive to a wide range of natural area recreational opportunities.

KUNUNURRA

Advantages

Educational and recreational facilities are reasonable in the town.

The town is set in an aesthetically pleasing location with access to a wide range of natural area recreational opportunities.

Kununurra is within a day's drive of Darwin.

Disadvantages

The climate is oppressive, particularly in summer.

There are no tertiary facilities available and cultural facilities are very limited.

CONCLUSION

Karratha offers the widest range and best quality structured facilities but it is not located in the most attractive natural setting.

The Department has indicated in the past that it wishes to upgrade Karratha to research centre status and allocate additional staff to the region. However, this has not yet been possible. Under the circumstances Karratha should be maintained as a place where research staff are based and it should be upgraded to research centre status as soon as possible.

PART 10 AIM AND PRIMARY OBJECTIVES OF RESEARCH DIVISION

These were reviewed in April 1988 by RDPG following the review of all Research Programs, and were approved by the Policy Directorate in August 1988.

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, increase and research the Herbarium collection of native and naturalized plants.

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 II THE PROGRAMS

Each of the 14 programs has, as far as practicable, a common format, as follows:

PROGRAM LEADER

CURRENT RESOURCES (1987/88) AND RESOURCES IN THE PREVIOUS YEAR (1986-87).

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.

BACKGROUND

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

AIM

This states what the Program should have achieved by 1993. 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 1988 TO JUNE 1993.

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 1987/88.

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 1987 and June 1988 is summarized. The column entitled Targets 1988-9 is intended to convey in a telegraphic style the works program for the period July 1988 - June 1989.

EXECUTIVE & ADMINISTRATIVE SUPPORT PROGRAM

PROGRAM LEADER

AA Burbidge

CURRENT RESOURCES

This program comprises 22.65 persons (5.15 Professional + 17.50 Clerical and Technical). Its budget is $984 377 (including 1 contract officer) ($638 220 salaries, $58 525 wages, $287 632 other).

RESOURCES IN PREVIOUS YEAR

16.9 persons (3.35 Professional, 13.55 Clerical and Technical), with a budget of $763 848 ($436 208 salaries, $87 540 wages and $240 100 other).

BACKGROUND

This service program is responsible for the direction and administration of all activities conducted within Research Division. Major changes in the past year include the appointment of Manager of the Division in June 1987, and the formation of the Research Division Policy Group (RDPG) in August 1987. Appointments to the vacant positions in this group were finalized in February 1988. As explained in Section 1 of this Plan, the RDPG consists of the Manager, the Senior Principal Research Scientist and Principal Research Scientist (Management), the Senior Principal Research Scientist and Principal Research Scientist (Science), and the Curator, Western Australian Herbarium. The WA Herbarium has only recently been transferred to Research Division. Therefore the goals of the Curator will be included in the next revision of this Plan. The 20 year goals and 5 year goals of the other 3 sub units, and of the Scientific Editor, are set out in detail below. All members of RDPG are expected to carry out relevant research.

AIM

To direct, lead and administer the Research Division.

PRIMARY OBJECTIVES

Executive Leadership

Through the 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 the Division's Administration, Staff and Finance team.

Communication

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

DIVISIONAL MANAGER

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 the Division's Administration, Staff and Finance Team, 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 Science Team ensure that research carried out by the Division is of the highest standard and is published.

5. With the assistance of the Management Team, ensure that research carried out by the Division is applied by the Department.

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

7. Supervise the Research Computing Program and ensure that it provides an appropriate service across the Division and promotes communication throughout the Department.

SENIOR PRINCIPAL RESEARCH SCIENTIST/ PRINCIPAL RESEARCH SCIENTIST (MANAGEMENT) TEAM

20 YEAR GOALS

1. Ensure that good working conditions and an *ésprit de corps* is developed and maintained among all personnel in the Division.

2. Develop good relationships between Research Division, other Divisional Branches within CALM, and outside organizations.

3. Ensure that all research done is relevant to the Management objectives of CALM.

4. Ensure that all useful and relevant information is used and put into practice by CALM Managers.

5. 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. Facilitate and organize with Research Scientists, Operational staff and other relevant Branches, the implementation of research findings (including the existing backlog) in management programs.

8. Ensure that each Research Scientist contributes substantially and usefully to management.

SENIOR PRINCIPAL RESEARCH SCIENTIST/ PRINCIPAL RESEARCH SCIENTIST (SCIENCE) TEAM

20 YEAR GOALS

1. Maintain and, where necessary, improve the scientific excellence of research carried out in Research Division.

2. Increase the production of well-written scientific papers and reports without compromising quality, and encourage authors to publish in the best journals available.

3. Ensure, as far as possible, that the research carried out by Research Division achieves a prestigious scientific profile within Western Australia, as well as nationally and internationally.

4. Facilitate external funding of research carried out by the Division.

5 YEAR GOALS

1. Initiate workshops, symposia, discussion groups or seminars to foster exchange of scientific ideas.

2. Ensure that all research is carried out in accordance with approved Research Project Plans (RPPs).

3. Co-ordinate the annual revision of the rolling Five Year Plan.

4. Initiate and implement a research accountability scheme and devise methods of comparing the productivity of Divisional scientists with that of other relevant organizations, both in Western Australia and nationally.

5. Supervise the Research Methods Program and ensure that it provides an appropriate service across the Division.

6. Co-ordinate, as an interim measure, research into environmental weeds and marine ecology.

7. Facilitate and encourage the gaining of higher degrees by research scientists.

8. Ensure that each scientist publishes on average at least one scientific paper per year and gives a formal seminar to CALM staff once every two years.

9. Expedite, in liaison with the Scientific Publications Editorial Committee, the rate of publication of papers submitted by Divisional Staff for publication in CALM journals.

10. Identify factors hampering the productivity of individual research scientists and arrange remedial action.

11. Improve the dissemination of research information to the public at large, school students, and the scientific community.

12. Facilitate presentation of scientific information at National Conferences by Divisional Research scientists.

13. Co-ordinate funding of promising Honours and Postgraduate students to undertake research of direct benefit to conservation and land management in Western Australia.

14. Investigate means of attracting outside specialists to spend time as visiting scientists at CALM Research Centres, in order to investigate topics for which CALM's expertise is not well developed.

15. Co-ordinate applications for external funds, advise scientists on the availability of external funds, and investigate sources of external funds.

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: the Senior Principal Research Scientist (Science), Principal Research Scientist (Science), Scientific Editor, and two other scientists from Research Division.

Dr S.D. Hopper (Chair)
Dr I. Abbott
Ms M. Lewis (Scientific Editor) (Secretary)
Dr T.D. MacFarlane
Mr G.L. Stoneman

Ms Lewis is a member of the Information Branch. She spends 95% of her time on scientific publishing, including editing of publications emanating from other Divisions.

The budget allocated for scientific publishing is $32 500 (1987/88 : $32 500). During 1987/88 the allocation for Research Division's scientific publishing was transferred from Services Division to Research Division.

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, Nuytsia, Kingia, Regional Flora Handbooks and Landnotes according to specifications in the Administrative Instruction 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 1987/88

*ABBOTT, I. (1988). Biogeography and its use for setting of priorities for management, pp 45-50 In : Saunders & Burbidge, cited below.

*BURBIDGE, A.A. (1988). The Why and How of managing biological resources, pp 9-14 In : Saunders & Burbidge, cited below.

*START, A.N. (1988). Management in uncertainty : Using the opportunity to adopt an experiemental approach to management, pp 51-52 In : Saunders & Burbidge, cited below.

*SAUNDERS, D. & BURBIDGE, A.A. (1988). Ecological theory and biological management of ecosystems : workshop summary and discussion, pp 77-85 In : Saunders & Burbidge, cited below.

*SAUNDERS, D.A. & BURBIDGE, A.A. (Editors) (1988). Ecological theory and biological management of ecosystems. CALM Occas. Pap. No. 1/88.

BIOGEOGRAPHY PROGRAM

PROGRAM LEADER

NL McKenzie

CURRENT RESOURCES

The program comprises 7.25 persons (3.65 Professional + 3.6 Technical). Its budget is $365 119 ($251 584 salaries, $930 wages, $112 605 other).

RESOURCES IN PREVIOUS YEAR

7.05 permanent staff (3.45 Professional + 3.6 Technical); 0.25 of State-funded temporary wages staff. Its budget was $336 565 ($215 000 salaries, $5930 wages and $115 635 other).

1.4 Commonwealth-funded consultancy staff (National Rainforest Survey Program, W.A.). Its budget was $151 250 ($37 050 wages and $114 200 other).

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; 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.

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.

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. 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 hetrogeneity of the quadrats? sampling methodologies including the use of remote sensing and sampling invertebates? 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 1988 TO JUNE 1989 (numbers refer to the Table following)

Database: 1,3,4,13,18,20,23,25

Reserve System Design and Land Use: 27,28,33,37,38,40,41

Management Planning: 47,48,50,54

PROPOSED NEW PROJECT - with existing resources

Edaphic, climatic and floristic pattern associated with the distribution of 3 forest Eucalypts *(E. brevistylis, E. jacksonii, E. guilfoylei)* restricted to the Walpole area of Western Australia.
G. Wardell-Johnson.

PUBLICATIONS * AND REPORTS 1987/88

BURBIDGE, A.A., McKENZIE, N.L. & KENNEALLY, K.F. (1987). Nature Conservation Reserves in the Kimberley, Western Australia. CALM, Perth. 164 pp.

*McKENZIE, N.L., KENNEALLY, K.F. & WINFIELD, C. (1987). Western Australia's rainforests. *Landscope* 3(2): 16-22.

*McKENZIE, N.L. (1988). Biogeography and its use for setting priorities for management. In: Ecological theory and biological management of ecosystems. (Eds: Saunders, D.A. & Burbidge, A.A.), CALM Occasional Paper 1/88.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Data Base	6,7	1	Develop micro-computer entry system for survey data RS122	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	Developmental -PATN acquired	Develop further
		3	Census of Australian Plants RS92	MS submitted	Organize plant master file
		4	Atlas of W.A. Proteaceae (except Banksia Grevillea) RS56	Maps for 6 genera finalized	Complete
	5,6	5	Searching vs pitfall trapping in Southern Forests RWP unallocated	Ongoing	Ongoing
		6	Sampling small ground-dwelling vertebrates RS16	No action	Analyse data
		7	Establish CALM monitoring program RS52	Endorsed by Policy Directorate	Begin implementation
		8	Heterogeneity of Nullarbor Quadrats RS121	No progress	Analyse
		9	Automatic bat assemblage sampling RS129	Recorded bat ultra-sounds for 20 species	Opportunistic
		10	Biogeography of flora of Southern Nullarbor RS92	Toolina re-surveyed	Continue as time allows
		11	Extending the Nullarbor data-base, do the patterns change RS120	Matrix updated	Analyse with extra data
		12	Biogeographic patterns versus soil attributes RS20	Field data collected and compiled by consultant	Analyse when time allows
Data Base, Reserve System Design and Land-use Advice	5,6	13	Ground-truthing the Nullarbor data-base RS124	Moopina & Naretha data incorporated and analysed	Write-up
	4,6	14	Ad hoc flora surveys of selected crown lands RS74	Reports to file 1 published, 1 draft	Transfer to Flora Conservation Program
		15	Walpole-Nornalup national Park survey RWP unallocated	Field work ongoing	Finish field work. Begin write-up
		16	Yanchep NP survey RS15, RS99	Sampling almost complete	Complete sampling then write-up
		17	Dryandra State Forest vegetation RS99	Deferred	Commence further fieldwork
		18	Boonanarring Reserve Survey RS15 RS99	In draft	Submit MS
		19	Perup Priority Area Survey RWP	No progress	Begin the study
		20	Southern Beekeepers Reserve Survey RS15	MS complete	Finalize publication
		21	North-west Islands Survey	Thevenard & Airlie Islands surveyed	Do fieldwork on Thevenard I.

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		22 Cape Arid Survey RS15, RS99	Quadrats established; first flora sampling done; flora list from existing collections	Finish field survey
		23 Fitzgerald River NP Survey RS127	MS completed & submitted for publication	Publish & incorporate quadrat data in CALM data base
	3,4,6	24 Eastern Goldfields RS121, RS122	Cell 8 in draft; Check and up-grade Cell 8 and Cell 1E vegetations; Goldfields bird data in data-base; Cell 6 in press	Finish field studies; Publish Cells 6 & 8; Prepare MS of Cells 9 & 5; Put Goldfields reptile and mammal and plant data in computer data-base
	1,6	25 Rainforest Survey	1987 and 1988 field surveys completed	Do wet season sampling; Identify specimens; Compile & analyse data; Write-up study as draft
	2	26 Irwin/Carnarvon survey RS126	Consultancy reports on geology & climate and late Holocene mammal fauna finalized; RAOU bird atlas acquired; Consultancies let for appraisal of existing flora data; Consultancy to appraise existing vertebrate fauna data not let	Survey deferred until 1989/90
Reserve system design and Land-Use Advice, Management Planning	6	27 Proposed Jibberding White Wells Reserve Survey	Draft	Publish
		28 Salisbury Island Survey	No progress	Publish
		29 Bucaneer Archipelago Survey RS128	No progress	Publish
		30 Dampier-Burrup Archipelago Survey		Compile available data
		31 Mandora Palaeoriver/Radi Hills Survey	No progress	Compile data
		32. Cooloomia Nature Reserve Survey RS75	No progress	Deferred
		33 Flora Survey of Islands: Lancelin to Dongara RS94	MS written	Publish
		34 Mt Leseueur Survey work RS60	No progress	Complete draft
		35 Stirling Range & Environs flora RS95	Rare flora mapped, draft prepared	Prepare annotated flora list
		36 Dorre Island and associated Shark Bay Island survey RS141	No progress	Re-sample at 15 years is due
		37 Bold Park flora survey	Fieldwork complete	Publish
		38 Benger Swamp Flora Survey	MS prepared & submitted	Publish
		39 Tutanning Survey work RS59	No progress	Complete draft
		40 Two Peoples Bay Survey Work RS63	Draft completed	Publish

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		41 Middle Island/Recherche Survey Work RS60	Draft completed	Publish
		42 Dampier Archipelago Survey RS132	Finished survey work	Prepare MS
	4,6	43 Monte Bello Island Survey RS132	No progress	Compile data
		44 Bird Communities of Walpole-Nornalup NP (RWP unallocated)	Ongoing	Prepare for publication
		45 Granite outcrop plant survey	Several surveyed and specimens lodged in Herbarium	Transfer to Flora Conservation Program
		46 Biogeography of Dugong and Seagrasses in northern W.A. RS142	No progress	Complete as opportunity presents
Management Planning	4,6	47 Dampier Archipelago Management Plan RS132	MS submitted	Publish
		48 Management guidelines for Monte Bello Island RS132	Draft prepared	Publish following extra fieldwork
		49 Bird census in southern forests (RWP unallocated)	No progress	Seeking funding
		50 Management Plan for North-west Islands	Contributed to Petroleum Company Management Plans	Provide advice as requested by Protection Branch.
		51 Interactions of fire and site on vegetation in the Walpole-Nornalup NP RWP unallocated	Ongoing	Complete field work
		52 Bucaneer Archipelago Management Plan	Continue to collect data	Deferred
	5,6	53 Bat assemblages: disturbance and determinism RS129	In press	Await publication
		54 Lizard litter patch guilds RS121	Data collected at 4 extra patches	Continue as time allows
		55 Distribution and taxonomy of Geocrinia complex RWP 1/83	Analysis complete	Draft 3 papers
		56 Community-types in regenerating Karri RWP 9/88	Field work complete. Mapping complete	Write-up

ENTOMOLOGY PROGRAM

PROGRAM LEADER

I Abbott

CURRENT RESOURCES

This program comprises 5.9 persons (1.6 Professional + 4.3 Technical). Its budget is $167 762 ($143 392 salaries, $24 370 other).

RESOURCES IN PREVIOUS YEAR

Entomological research was previously carried out in the Jarrah Forest and Plant Pests and Diseases programs.

BACKGROUND

The entomology program was formed as a result of a recent review of all research 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 1993 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.

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 an atlas 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 infestations.

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 1988 TO JUNE 1993
(numbers refer to the Table following)

1, 2(part), 6, 7, 23, 24, 27, 30, 33, 37, 38, 39

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

Jarrah Leafminer : 3, 4, 28; Gumleaf Skeletonizer : 10, 31, 12, 13, 14, 15; Lerp : 16, 17, 18, 19, 20, 32, 36

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

Jarrah leafminer : 5, 26; Gumleaf Skeletonizer : 11, 34, 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 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 1987/88

ABBOTT, I. (1987). Review of past and current research into insect problems in the Jarrah forest, with recommendations about the future direction of research. Unpublished report, 73 pp.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Ecological Knowledge	Jarrah Leafminer (JLM)	1	Impact on wood growth		
			45/87	13 Collie Inventory plots measured and analysed	Prepare for publication
			24/86	Dwellingup - manual defoliation of ground coppice	Measure wood growth Dec 88
			27/84	Manjimup - Cardac insecticide experiment completed	Analyse results
			57/86	No action	Extend survey to most heavily infested stands
			60/86	Manjimup - analysis completed	No further research planned
		2.	Annual monitoring of defoliation		
			44/87	20 Plots installed Collie District October 87	Measure damage to tagged leaves Sept 88 and analyse by ML Regression
			20/84	New leaves tagged in 20 plots in Manjimup District 87	Measure damage to tagged leaves Nov 88 & Select new cohort
			20/84	Leaves tagged Nov 84 in Manjimup District measured for damage in Nov 87	Measure damage to tagged leaves Nov 88
			20/84	Leaves tagged Nov 84 in Manjimup measured for damage in Nov 87, Feb 85	Measure damage to tagged leaves in Nov 88
			20/84	Leaves tagged Nov 85 in Manjimup District measured for damage in Nov 87, Feb 88	Measure damage to tagged leaves in Nov 88
			2/85	New leaves tagged in 20 plots in NJF in Nov 87	Measure damage to tagged leaves Nov 88
		3	Crown decline 45/87	Collie Inventory plots surveyed	Do aerial survey of forest in Collie District Oct 88 Quantify crown damage caused by JLM on CSIRO plots around Manjimup New project : Photograph crowns of selected trees within and N of outbreak boundary in Collie and Harvey Districts. Prepare RPP
		4	Tree mortality	-	"
		5	Cause of outbreak	-	New project : Prepare RPP Computer modelling using maps of outbreaks 1962 - present
	Gumleaf Skeletonizer (GLS)	6	Annual cycle of GLS, predators and parasitoids (23/85)	Sampling July 87, Oct 87, Jan 88 Sorting of samples July 87 and Oct 87 completed	Finish sorting of samples; analyse and write up. Annual sampling of 45 trees Jan 89
		7	Distribution of GLS N of outbreak zone (48/87)	Surveyed Sept 87 S Kirup District & N Manjimup District	Extend into N Kirup & S Collie Sep 88

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		8 Annual monitoring of outbreak	Not done Jan 88 (Technician nominated failed to perform task)	Do Jan 89 (Spotter aircraft) Liaise with CSIRO remote sensing unit
		9 Crown decline (61/86)	Photography done	Assess photographs & decide on frequency of photography Rate & photograph crowns of 45 trees in Jan 89 (last done Jan 87)
		10 Tree mortality	-	New project : Prepare RPP
		11 Cause of outbreak	-	New project : Prepare RPP
		12 Uraba taxonomy	-	New project : send samples to Waite Institute for comparison with S.A. Uraba specimens
		13 Survival of caterpillars	-	New project : Prepare RPP
		14 Spatial distribution of pupae	-	New project : Prepare RPP
		15 Fecundity in relation to pupal mass		New project : Prepare RPP
	Lerp	16 Life cycle studies	Tagged leaves photographed (P. Albone)	New project : Select study sites & prepare RPP
		17 Taxonomy	-	Collect adults to send to taxonomist
		18 Crown decline	-	New project : Select study sites & prepare RPP
		19 Tree mortality	-	"
	Pests of pine	20 Annual monitoring		
		21 Section for new edition of Pine Manual	Completed	N/A
	Other insects (potential pests) in jarrah forest	22 Assemble basic life history details, distribution	Data collected opportunistically	Opportunistic
	Tryphocaria borer in karri	23 Distribution & intensity of infestation (32/85, 59/86)	Field work & preliminary analysis completed	Incorporate G. Inion's plot data into analysis & write up
	Termite occurrence in Perth Metro area	24 Species present and location of 'hot spots' in Metro area ; Damage impact	500 vials distributed to Pest Control companies	Complete, hire consultant to sort and analyse samples (funded by WURC)
	Curation, maintenancce & 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	Spirit-collection re-organized & relabelled	Complete computerized data-base for spirit-collection & incorporate SJF samples. Obtain better housing for collection
Stand Management	JLM	26 Stand hazard rating	CSIRO/CALM Workshop organized April 88	New project: Prepare RPP
		27 Frequency of occurrence of resistant trees in NJF (45/87)	13 Collie Inventory plots surveyed	Analyse data
		28 Effects of fire and thinning	CSIRO/CALM Workshop organized April 88	New Project : Install experiment examining autumn fire impact in Collie District : Prepare RPP

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
	GLS	29 Stand hazard rating	-	New project : Prepare RPP
		30 Effect of fire on GLS, predator & parasitoid abundance (19/87)	Budget limitations forced deferment of Jan 88 sampling	Resample Jan 89. Reschedule Autumn fire for Autumn 89
		31 Effect of thinning	-	New project : Prepare RPP
	Lerp	32 Resistant trees	-	Select study sites & prepare RPP
Control	JLM	33 Impact of parasitoids (47/87)	All blocks between Marradong Rd & Collie Dist. surveyed	Extend survey to N of Marradong Rd
		Choice of 'best' parasitoid for intensive ecological study	CSIRO/CALM workshop organized April 88	Take decision
	GLS	34 Biocontrol	-	New project : Prepare RPP
		35 Predation by birds (39/86)	Sampling abandoned : returns not commensurate with effort	No further research
	Lerp	36 Biocontrol	-	Sample for parasitoids & prepare RPP
	Ips	37 Prescription for introduction of parasitoids and predators	Draft written	Finalize & begin introductions
	Sirex	38 Prescription for introduction of nematodes and parasitoids	Draft written	Finalize
		39 Contingency Plan should Sirex be introduced	Draft written	Finalize

FAUNA CONSERVATION PROGRAM

PROGRAM LEADER

RIT Prince

CURRENT RESOURCES

Human resources comprise: CALM Professional Staff, 4.40 FTE; CALM Technical and Wages Staff, 4.70 FTE; 0.5 contract Professional FTE and 1.00 contract Technical FTE.

Financial support is: CALM Professional salaries, $188 774; CALM Technical salaries and wages, $145 565; CALM research support funds, $42 245; external source research support funds, $50 700.

RESOURCES IN PREVIOUS YEAR

Resources available to this program as listed in the "Research Plan - July 1987 to June 1992" show only the level of staffing and research support provided directly via CALM and CRF funding. Figures in that document are not therefore comparable with the listing above.

Figures compiled similarly to "Current Resources" show that total personnel involved in research in the Fauna Program area in the year 1987-88 was 14.75 comprising 4.55 externally supported persons and 10.20 CRF supported persons. The reduction in effort anticipated for the current year arises from completion of one volunteer supported project, ending of external support for another, and the sum of transfers, promotions and increases in administrative service requirements within the CALM supported component.

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.

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 1988 TO JUNE 1993

Year	Project Nos.
1989	3, 9, 14, 15, 33b
1990	1, 6, 7, 10, 13, 16, 18, 22
1991	17, 19, 21, 26, 28, 31, 32
1992	20.
1993	2, 4, 5, 8, 12, 23, 24, 27, 29, 30, 34, 35.

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

Nil.

PROPOSED NEW PROJECTS - with existing resources

Nil.

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Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Knowledge	Specialized knowledge	1	Mormopterus taxonomy (RS130)	Data analysis progressed; completion requires external collaboration	Complete work
		2	Australian landhoppers (RS44)	Publication of monograph on Tasmania fauna	Identify collection from E. Gippsland. Enter data into Floraplot program to enable Australia-wide maps to be plotted
		3	Decline of W.A. mammals (RS8)	Paper in preparation	Complete & submit paper
		4	Mardos and karri tree hollows (6/84)	Nest boxes in place (in association with bird study)	Collect data
		5	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	6	Fox as predator (RS104, 105-111)	Baiting trials. Density indices trials. Population data collected. NaCN sampling technique. Establishment of new study site, Watheroo NP. Fox diet studies, Fitzgerald River NP. Small mammal trapping, Fitzgerald River NP	Estimate density, home range, social structure, calibrate density indices. Baiting trials, bait potency trials. Prey species FRNP. Bait trials ongoing
	Biology, ecology	7	Karri forest bird communities (22/82, 22/86)	Data for spring 1987, summer 1987-88 collected & data file for analysis completed	Analyse data, commence write-up
	Biology, ecology; public involement; contact with Regions	8	Marine turtle conservation (RS144-145, 132-133)	External funding secured, field program executed, recovery of turtles documented, Aboriginal communities involved in work, continuation funding sought	Proceed with development of project as specified
	Biology, ecology	9	Ecological studies of three species of tree rats (1987)	Field work completed; data analysis underway	Prepare paper with collaborators
	Biology, ecology; techniques; contact with Regions	10	Bird communities of Walpole Nornalup NP (?1987)	Continued census work, data analysis progressed	Complete analysis, write up
	Identify relict populations; increased understanding	11	Western desert fauna (?1987)	Surveys of fauna in Great Victoria Desert initiated	Ongoing
Knowledge; Population Studies	Specialized knowledge; biology and ecology; specific applications	12	Dugong conservation (RS142-144)	Salvage specimens collected; data from previous studies part analysed; application to Shark Bay conservation proposals assessed; integration with external research in progress considered; assistance with planning for publicity, Shark Bay	Prepare proposal for detailed census of Shark Bay & Exmouth Gulf populations obtained; seek necessary funds to implement in association with external research workers while special opportunity available
	Identify relict populations; specialized knowledge; potential impacts of feral exotic; management support; biology and ecology	13	Rock Wallaby conservation (RS103, 104-105)	Kalbarri, Wheatbelt, Cape Range NP RW population monitored, Edgar Range populations survey, Dryandra marsupial survey	Continue monitoring Kimberley RW; Nookanbah pop survey. L. Argyle RW Survey.
	Management support; biology and ecology	14	Rock Wallabies, Dampier Archipelago (RS108)	Paper in preparation	Submit for publication

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
	Identify relict populations; management support; biology and ecology	15	Rock Wallabies, East Pilbara (RS108-109)	Paper in preparation	Submit for publication
	Management support, biology and ecology	16	Numbat habitat and food sources (RS39-41)	Post-fire sampling & analysis of data from termite & log plots	Complete papers on feeding activity & termite activity. Complete management plan.
	Identify relict populations; management support; biology, ecology	17	Chuditch conservation (RS147-149)	Field studies progressed as planned	Develop management protocols, conduct surveys to establish presence/absence of Chuditch in suitable habitat
	Management support; biology, ecology	18	Western Barred-bandicoot (RS43-44)	Spotlight surveys, determination of home range & overlap, habitat use. Collected scat samples, August 1987.	Arrange field trips in August 1988 and March 1989 to test seasonal change in habitat use hypothesis.
	Management support; biology, ecology	19	Ground parrot conservation, preliminary studies (RS17-18)	Pilot project commenced, funding applications to WWF for field surveys and habitat use & ANPWS for FRNP census	Continue low-key FRNP work; upgrade surveys etc to major project when external funds provided (WWF have advised sponsorship)
	Management support; biology, ecology	20	Mammals of Pilbara Islands	Proposals developed for Leggadina forresti on Thevenard Island following House Mouse invasion	Proceed with Thevenard Island work re Leggadina forresti conservation & House Mouse invasion.
	Identify relict populations; develop management support programs	21	Pseudomys praeconis surveys	Preliminary survey undertaken; funding application accepted by WWF	Proceed further if/when funds providedIdentify relict populations; develop management support program
		22	Hooded Plover conservation	Funding application prepared & submitted to ANPWS	Proceed in association with RAOU if funding provided
	Identify relict populations; specialized knowledge; biology, ecology; public involvement	23	Western desert mammals (?1987)	Surveys of Bilbies in Gibson Desert; establishment of contacts with Aboriginal communities and funding sources to facilitate specific survey program	Conduct surveys of Brushtailed Possum & Rock Wallaby occurrence in ranges country in association with Aboriginal communities
	Management Support	24	Western Swamp-Tortoise breeding (RS9-10)	Funds secured via WWF, consultancy work in progress	Continue
	Management support; techniques	25	Western Swamp-Tortoise populations (RS9-10)	Seasonal work completed as required	Continue
	Management support, biology, ecology	26	Numbat translocation and restablishment (RS43-43)	Boyagin & Karroun Hill translocation enacted. Monitoring both populations through year	Complete management plan. Publish reports to WWF. Involve operations staff in field trials
	Management support, biology, ecology	27	Banded Hare-Wallaby, Stage 3 (RS141)	Project suspended due to land tenure problems at Shark Bay & insufficient funds	Rreactivate if problems solved
	Management support; techniques	28	Woylie Populations (2/83)	Major monitoring in suspense	Monitor Perup release area

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
	Management support; techniques	29	Woylies in NR's etc. (RS102)	Trapping work, monitoring of occurrence at Dryandra, Tutanning & Boyagin NR's, Fitzgerald River NP	Continue
	Management support; techniques	30	Saltwater Crocodile populations (RS12-13)	Work in suspense due to promotion	Seek new staffing
Population Studies; Management Applications	Potential impacts of feral exotic; control programs; techniques; contact with Regions	31	Exotic fauna, rats on islands (RS134-135)	Work in suspense due to technical problems re target specificity	Prepare paper on work undertaken to date; reassess applications
Management Applications; Public Involvement	Specific applications; management of exploitation; public involvement	32	Dugong and marine turtle management (RS142-145)	Agreement in principle reached on approach to Dugong management, West Kimberley; contract for field investigations by community secured via ANPWS	Proceed with development of plan
Management Applications	Field study techniques	33.	a) Pitfall trapping methods (RS16-17) b) (RS34)	No action Publications in press & submitted	Opportunistic Use; apply
	Specialized knowledge; specific needs; techniques; contact with Regions	34	Seabird database	Database maintained & updated; paper prepared	Continue; paper(s) integrating knowledge to be prepared
	Specialized knowledge; specific needs; techniques; contact with Regions	35	Island fauna database	Database maintained & updated; data incorporated into draft paper	Continue; submit paper
	Techniques; administrative support	36	Kangaroo management programs	Participation in review of scope of management programs initiated via NPNCA Fauna Committee; Harvest quota advice provided	Ongoing

FIRE PROGRAM

PROGRAM LEADER

N Burrows

CURRENT RESOURCES

This program comprises 15.8 persons (5.35 Professional + 10.45 Technical). Its budget is $674 864 ($511 924 salaries, $3 605 wages, $159 335 other).

RESOURCES IN PREVIOUS YEAR

12.3 persons (4.5 Professional + 7.8 Technical); with a budget of $475 759 ($349 489 salaries, $8 520 wages and $117 700 other).

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.

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-suppressiona 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.

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 *Lambertia rariflora*.

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.

d. Communication

1. Publish proceedings on National Fire Management Workshop held in Busselton, 1987.

2. Continue to hold formal and informal workshops, meetings and seminars for researchers, managers and community groups.

3. Continue to publish findings and to produce management guidelines.

4. Continue input into land management plans.

PROJECTS TO BE COMPLETED FROM JULY 1988 TO JUNE 1993 (numbers refer to the Table following)

1,2,3(part),5,8,10,11,13,15,16,18,19,20,21,28,30

PROPOSED NEW PROJECTS (with additional resources)

1. Fire regime effects on selected gazetted rare and endangered flora.

2. Fire regime effects on fire vulnerable flora.

3. Fire regime effects on nutrient regimes in forests.

4. Fire regime effects on understorey species - woodlands.

5. Fire regime effects on northern sandplains vegetation.

6. Fire regime effects on south coast heathlands vegetation.

7. Fire regime effects on mammals - heathlands.

8. An integrated, computerized fire management system for forests.

9. Fire behaviour and fire effects - Banksia low woodlands.

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WARD, B.G. Fuel accumulation rates in southern wetlands.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-8	Targets 1988-9
Fire Behaviour and Suppression	Fuel reduction guides for karri regrowth	1	Karri regrowth fuels 2/84	First draft submitted for publication	Revise draft
		2	Prescribed fire behaviour 21/85	Field work, some data analysis	Complete data analysis
		3	Fire damage to karri regrowth 15/85	Annual re-measurement of tree growth, crown response and fuel accumulation	Re-measure March 89
	Fire behaviour in heathlands and mallee shrublands	4	Fire behaviour in heathlands and shrublands 22/88	Detailed research proposals prepared and experimental sites selected at Stirling Range NP. Preliminary investigations into techniques for measuring fire spread	Establish plots and complete pre-burn assessment. Commence burning program
	Fire behaviour and fuel models - hummock grasslands	5	Spinifex drying trials - 42/87	Literature review, pilot study Queen Victoria Spring N.R.	Conduct detailed diurnal studies Sep 1988 & March 1989
		6	Describing fuel structure and biomass 23/88	Line transects sampled using wheel point method. Progress in relating fuel characteristics to landform units	Prepare paper for publication
		7	Fire behaviour studies 42/87	30 experimental burns completed; Mark I fire model produced	Plan further studies Sep 1988 & March 1989
		8	Historical weather data - Giles 24/88	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	Aero burn sites selected and fuels measured. Airstrip prepared, fuel arranged	Plan large scale aero burns in Gibson Desert Nature Reserve for Sep 1988
		10	Thematic mapping fire patterns 26/88	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	Fire maps in preparation from I/R scan data	Complete data extraction from fire maps
		12	Lab studies of fuels (combustion rates) 18/86	Preliminary analysis of data	Complete data analysis
		13	Spot fire development 14.86	Preliminary analysis of data	Complete data analysis
		14	Fire caused injury to jarrah/marri 18/78	Final publication	-
		15	Wildfire threat analysis 27/88	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	16	A computer system for storing, retrieving and analysing wildfire data 15/86	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.
		17	Fuel studies in southern wetlands 47/86	Fourth annual remeasurement of structure and biomass. Progress reports submitted	Remeasure in June 1989. Submit progress reports

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-8	Targets 1988-9
		18	Soil Dryness Index for use in W.A. fire control 30/83	Final publication	Test for locations outside forest regions, especially wheatbelt, northern sandplains, south coast
	Prescriptions for prescribed burning in pine plantations	19	Slash burning guides for P. radiata plantations 19/78	Submitted for publication. Operational guides tested	Monitor operations, refine guides where necessary
		20	Controlling Pine wildings with prescribed fire 16/86	Draft prepared on. Operational guidelines submitted	Prepare for final publication. Monitor operational burns, refine guides if necessary
		21	Assessing the effectiveness of grazing in fuel reduced buffers 29/88	Preliminary investigation into impact of grazing on selected buffers - Blackwood Pines	Measure grass biomass production in grazing leases
	Fuel and fire behaviour studies in Banksia low woodlands	22	Fuel accumulation rate and structure in Banksia low woodlands 17/86	Preliminary investigation complete. Paper submitted for publication	Published preliminary study. Select sites for further study. Commence assessment
Fire Ecology	Effects of fire on forest understorey plant species and some animals	24	Effects of 5 fire regimes on forest understorey species 12/86	Sites located, plots constructed, pre-burn assessment done. Two sites burnt and post burn assessed. Soil nutrient samples taken	Burn third site in Jan 1989. Complete seedling counts, biomass, photography at other sites. Analyse soil nutrients
		25	Effects of 3 fire regimes on ground-dwelling invertebrates RS36, RS37	Trap grids in place. Post summer burn trapping continuing. Seasonal sampling of all treatments commenced	Continue seasonal trapping of all treatments
		26	Fire and the Tammar Wallaby 7/84	Annual assessment of post-burn thicket development	Continue annual assessment and description of habitat redevelopment. Submit progress reports
		27	Fire effect on Lambertia rariflora 23/87	Sites located, pre-burn assessment completed. Burn postponed due to very dry weather	Burn site in March 1989. Assess postfire mortality & recruitment. Prepare progress report.
		28	Fire, season and termite activity (with respect to food base for Numbat) 8/84	Seasonal assessments completed. data partially analysed	Complete analysis of data, prepare paper for publication. Prepare management guidelines
		29	Fire and regeneration of E. wandoo 13/88	Study sites assessed and burnt	Assess in Oct 1988. Prepare progress report
	Fire effects - semi arid land (wheatbelt) reserves	30	Pitfall trapping and sampling techniques RS34	Paper prepared and submitted for publication	Await publication
		31	Effects of prescribed burns on fauna in wheatbelt nature reserves RS34 RS35	Seasonal trapping and data analysis. Preparation for burning	Continue trapping. Assess habitat & fuels of burn sites this season. Do post burn trapping
		32	Fire effects on vegetation of Tutanning N.R. RS62 RS63	Annual assessment	Do annual assessment & prepare progress report
	Fire effects - heathland and shrublands	33	Fire effects on vegetation - Two Peoples Bay R.R. RS63	Annual assessment. Several draft publications, guidelines for managers - draft management plan	Do annual assessment. Complete publications on 1st 10 years' results

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-8	Targets 1988-9
		34	Fire effects on vegetation - Recherche Archipelago RS60 RS61	Annual assessment and progress report	Do annual assessment. Complete publications on work to date
		35	Regeneration after wildfire Mt Lesueur N.R. RS60	Annual assessment of program report	Do annual assessment
		36	Fire effects on vegetation - Stirling Ranges N.P. 30/88	Detailed research proposals submitted. RPPs being formulated. Study sites selected	Construct plots, finalize RPPs pre-treatment measures & commence burning program
		37	Fire effects on reptiles, frogs and small mammals, Stirling Ranges N.P. 31/88	As above	As above, plus commence pre-treatment trapping on seasonal basis & describe habitat description
		38	Effects of various fire control strategies on vegetation 15/87	Analysed data from BFB chaining trials. Plots established Kalbarri N.P. to study chaining and burning treatments	Prepare BFB data for publication. Do annual assessment in Kalbarri & Watheroo N.P.s.
	Fire effects - hummock grasslands	39	Effects of mosaic burns on birds 20/88	Study sites located. Pre-burn census and analysis of variance completed	Do pre-burn census Sep 1988. Burn treatments & do post-burn census
		40	Effects of season of burn and fire size on desert vertebrates 32/88	Trapping in June, September, December 1987, March, June 1988. upgraded firebreaks resolve taxonomic problems	Do trapping in Sep & Dec 1988. Do intense post-burn trapping to obtain life history of Sminthopsis psammophila. Analyse trapping data
		41	Effects of fire on medium-sized desert mammals 38/88	Preliminary trapping, radio-tracking of Dalgyte (Macrotis lagotis)	Do pre-burn radio tracking Sep 1988; burn study site. Do post-burn radio tracking Sep & March 1989
		42	Effects of fire season & intensity on floral succession 33/88	Literature review, plot preparation Queen Victoria Spring N.R. Reference collection of local flora	Sample biomass, commence burning program & do post-burn assessment quarterly
		43	Effects of patch burning on lizards 34/88	Selection of study site. Collection and identification of specimens	Prepare detailed RPP. Commence pre-treatment trapping in Sep 1988. Continue trapping quarterly.
		44	Appraisal of thematic mapping for mapping vegetation 35/88	Acquisition of imagery, preliminary ground truthing	Continue ground truthing, compare with aerial photography, report to managers
Fire Management	Computerized fire management system - Tutanning N.R.	45	RS59 RS62	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. Judy Beck is preparing computer system for fire behaviour/suppression)	46	36/88		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	47	37/88	Extensive taped interviews with Mantjiltarra/Pitjantjarra women. Ethnobotanical information collated from literature and field work.	Continue with taped interviews. determine past land use of desert reserves.

FLORA CONSERVATION PROGRAM

PROGRAM LEADER

DJ Coates

CURRENT RESOURCES

This program comprises 5.7 persons (3.55 Professional (including 2.0 Contract) + 2.15 Technical). Its budget is $198 483 ($132 673 salaries) and $65 810 other).

RESOURCES IN PREVIOUS YEAR

6.0 persons (4.1 Professional (2.7 contract) + 1.9 Technical) with a budget of $190 000 ($121 300 salaries $69 000 other).

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.

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 1988 TO JUNE 1993
(numbers refer to the Table following)

4,8,9,10,11,12,13(part),17,18,19,21,22,23,24,25,27, 28,29,31(part),39(part),40,41,43,44,47,49

PROPOSED NEW PROJECTS - with existing resources

Nil

PROPOSED NEW PROJECTS - with additional resources lin 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.

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Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Rare and Endangered Flora	Field surveys Review schedule	1	Field surveys of rare and endangered flora	Several surveys completed	Continue surveys as time permits
		2	Additions and deletions Declared Rare Flora RS66	New schedule through	Revise schedule
	Data base	3	Data base rare flora RS69	Data base updated and partly computerized	Continue data acquisition/computerization
		4	Eucalyptus caesia	Field work near completion	Complete field work, data analysis, write up MS
		5	Eucalyptus macrocarpa	Nil	Defer
		6	Eucalyptus carnabyi	Nil	Defer
		7	Hybrids	Field studies of hybrid eucalypts	Defer
	Wildlife Management Plans	8	Acacia anomala	Data collection complete	Publish management plan, inspect quadrats
	Monitoring quadrats	9	Northern Forest Region	MS near completion	Publish management plan
		10	Drakaea jeanensis	Permanent quadrats inspected	Continue quadrat work
		11	Banksia cuneata	Data collection near completion	Publish management plan
		12	Stylidium coroniforne	Quadrats monitored, data collection near completion	Complete data collection, prepare management plan & inspect quadrats
		13	Conservation genetics RS26.		
			Banksia species	Isozyme studies completed on 2 species, underway on 2 species	Prepare data for publication, continue isozyme studies
			Grevillea species	Material collected on all species Declared Rare	Commence isozyme studies
			Eucalyptus rhodantha	Isozyme studies finished, analysis complete	Prepare PhD thesis and papers for publication
		14	Genetic systems RS26	Studies initiated on 9 species	Continue
		15	Life history, eco-geography RS26	Monitoring quadrats set up on popns of 20 species	Continue monitoring, set up quadrats on other species
		16	Germ plasm storage RS27	Seed collections started on 8 species	Continue seed collections, arrange long term storage
	Rare flora publications	17	Book on rare and endangered flora	MS nearly complete, slides and drawings collated	Finish MS submit for publication
		18	Review rare flora conservation in W.A. RS73	Literature review underway	Continue review
Flora Data Base	W.A. Flora biosystematics, conservation status	19	Eremaea RS30	Data analysis complete	Prepare MSS, submit for publication
		20	Dryandra RS56		
		21	Caladenia, Drakaea	Field collections finalised, herbarium data collated	Write up & submit to Nuytisa
		22	Caladenia, Chloraea RS79	MS revised	Submit for publication
		23	Eucalyptus wandoo and allies RS80	Field studies of 3 new taxa, MS partly written	Complete MS & submit for publication
		24	Salt Lake Eucalypts	Accepted for publication in Nuytsia	

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		25	Twenty new eucalypts RS81	Field studies, glasshouse trials completed, MS partially written	Prepare MS for publication
		26	Tremandraceae RS95	Field data on computer	Further field surveys in the wheatbelt
		27	Beaufortia, Regelia RS8	Field surveys near completion	Check types, prepare MS
		28	Creeping Triggerplants RS18	Further fieldwork carried out	Prepare MS
		29	New eucalypts/ taxonomy RS81	Field studies completed, glasshouse studies initiated	Complete glasshouse studies, prepare MS
		30	General Systematics RS97	Liliaceae complete	Opercularia commenced
		31	Stylidium	Field studies continued, finalized taxonomy of S. caricifolium complex	Continue field studies prepare S. carcifolium MS for publication
		32	Granite rock endemics - wheatbelt	A few rocks surveyed	Continue surveys as field schedule allows
		33	Granite rock endemics - karri	A few rocks surveyed	Defer
		34	Granite rock endemics - pastoral areas	Nil	Survey Mt Magnet rocks
		35	General biology RS97	See other sections	Continue studies
		36	Rapidly declining species RS30	Studies started on B. ilicifolia	Commenced field collections, do isozyme studies on tuart, analyse B. ilicifolia data
		37	Stylidium hybridization RS31	Material collected for isozyme studies, species surveyed	Start isozyme/chromosome studies, finalize surveys
		38	Naturalized Flora	Surveys of weeds of Banksia woodlands completed	Start surveys of Cape Naturalist Yanchep Nat. Parks.
		39	Orchids Stirling Range	MS partly finished, illustrations collated	Complete MS
		40	Orchid pollination book	Nil	Prepare MS and submit for publication
		41	Native trees Perth RS77	MS mostly written, illustrations prepared	Complete MS and submit for publication
	Orchid Atlas	42	Complete Orchid Atlas RS76	Nil	Include in proposed orchid book MS
	Eucalypt Atlas. Public involvement rare flora	43	Complete endangered eucalypt atlas	All field guides completed and 4 published	Publish last field guide, continue survey, prepare report
Wildflower Industry	Management plans	44	Kangaroo paws RS72	Field studies finished, write up partly complete	Complete M.App.Sci thesis, submit report to ANPWS
		45	Genetics, conservation status of 4 species RS29	Material collected from Banksia coccinea for isozyme studies	Start isozyme studies
		46	Management Plan Anigozanthos pulcherrimus, Macropidia fuliginosa	Data collection complete	Defer
	Harvest and Boronia	47	Boronia utilization and distribution	Boronia report completed	Prepare Boronia management plan

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
	Review research after licensing changes	48	Licensing and management RS70	Wildflower Industry Review Committee met 3 times. Working party report prepared	Finalize report of Wildflower Industry Review Committee
	Field Herbaria	49	Establish field herbaria RS32	Field herbaria established at 51 localities. Training courses continued	Arrange Training Course at Kununurra

HERBARIUM PROGRAM

PROGRAM LEADER

Curator (Vacant)

CURRENT RESOURCES

The program comprises 18.20 persons (11.70 Professional (including 1 contract) + 5.50 Technical (including 1.5 contract + 1 Wages.

Its budget is $610 000 salaries (including $85 000 ABRS grants), $21 000 wages and $186 980 operating budget.

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. 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 1 500 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 and other families will have been completed for the Flora of Australia project.

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.

PRIMARY OBJECTIVES

Curation

To implement efficient curatorial procedures, to identify deficiencies in existing specimen holdings, to make suitable collections, and to make specimens available for research.

Plant taxonomy

To discriminate and describe plant taxa using basic and applied research methodology, and to assist and collaborate with other scientists conducting such research. To interpret and promulgate the findings of research in appropriate scientific journals, floras, checklists and other publications.

Extension and education

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.

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 data base.

4. Complete the latitude and longitude program for the WA HERB specimen data base.

5. Maintain a census of W.A. plant names and develop it as an accessible computerized data base.

6. Complete the Public Access 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 data base.

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 1988 TO JUNE 1993

12,13,15-17,19,21-23,27-33,35-52,54-60,62-80,84, 85,88-107,109-122,124,127-131,138,139

PROPOSED NEW PROJECTS - with additional resources

Integrate Herbarium data bases with other relevant CALM data bases.

PROPOSED NEW PROJECTS - with existing resources

W.A. Regional Flora, south west region

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Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
Curation	Maintain Herbarium collections	1	Curation of allocated phanerogamic families. (All staff).	Incorporation of new & revised specimens. Updating of nomenclature. Monitoring of specimen order, maintenance & insect control. Loans of specimens.	As for 1987/88 & provide extra storage facility.
		2	Curation of cryptogams. (N.G. Marchant; other staff).	As above.	As above.
		3	Name incoming specimens & retain suitable ones for herb. PERTH. (S. Patrick, R.J. Cranfield, all Botanists).	Specimens named; retained where appropriate.	Continue as for 1987/88.
		4	Mount, label, etc. specimens retained at herb. PERTH. (Technical staff).	Specimens processed.	Continue as for 1987/88.
		5	Photograph Type specimens. (R.J. Cranfield).	Loan specimens photographed.	As above.
	Maintain and develop WAHERB specimen data base.	6	Managing WAHERB system. (T.D. Macfarlane, N.S. Lander, B.R. Maslin).	Maintenance of system achieved. Funds to expand specimen input applied for. Investigated latitude/longitude generation program.	Attend UNIX courses. Complete latitude/longitude program. Investigate funding sources to complete data base. (T.D. Macfarlane, N.S. Lander).
	Maintain and develop WAHERB specimen data base	7	Specimen entry into WAHERB. (Various staff).	Specimens entered & existing entries updated.	Enter & update specimens as required.
	Maintain and extend public access Reference Herbarium	8	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.
	Maintain and develop Census of W.A. plant names.	9	Update data files; compile & publish supplements. (J.W. Green; N.S. Lander; various staff).	Oct & June supplements compiled & published.	Compile & publish Nov 1988/May 1988 supplements.
		10	Develop data base from current Census files. (N.S. Lander; T.D. Macfarlane; B.R. Maslin).	Familiarization with current system & procedures.	Do feasibility study.
	Provide index to information on taxonomy of W.A. plants.	11	Develop index systems. (P.G. Wilson; Librarian).	Index cards prepared for current year.	Instruct librarian as to methodology & implement system.
Plant Taxonomy	Revisionary studies: (a) Asteraceae: Astereae	12	Camptacra: nomenclature. (N.S. Lander).	Paper published.	-

Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
		13	Minuria: revision. (N.S. Lander).	Paper published.	-
		14	Olearia: revision. (N.S. Lander).	Preliminary herbarium & field studies conducted.	Resolve W.A. species-groups. Describe NSW taxa & publish precursor paper & flora treatment. Prepare paper on O. pannosa group as a new genus.
				Preparation of a paper on members of the O. stuartii complex.	Correct proofs, etc.
				3 papers drafted (one with N.G. Walsh, Victoria) describing nex taxa from W.A., Vict. & Tas.	Complete papers.
				Specimens of O. axillaris complex examined at BM, DEN, K, MEL and TCD.	Complete elucidation of taxa & prepare MS.
	(b) Asteraceae: Heliantheae	15	Xanthium: taxonomy, namenclature. (G. Perry; P. Michael, Sydney).	Examined material at herb. B, BM, E, K, L, LINN, NSW, etc. Assessment of morphological characters & preliminary grouping of taxa; draft descriptions of 4 species prepared.	Investigate relevant typification. Continue preparation of species descriptions. Submit 2 papers for publication.
	(c) Asteraceae: Inuleae	16	Helipterum-Helichrysum generic classification. (P.G. Wilson).	Assessment of morphological characters; grouping of taxa.	Complete MS.
		17	Taplinia: a new genus. (N.S. Lander).	Paper submitted for publication.	Correct proofs etc.
	(d) Boraginaceae	18	Halgania: revision. (K.F. Kenneally).	Field studies on-going.	Continue.
	(e) Chenopodiaceae	19	Generic classification. (P.G. Wilson).	Paper published.	Ongoing.
		20	Halosarcia: taxonomy. (P.G. Wilson).	-	Collect material of the known but undescribed species.
	(f) Colchicaceae	21	Wurmbea: taxonomy. (T.D. Macfarlane).	-	Prepare MS describing a new species; field studies.
	(g) Dasypogonaceae	22	Chamaexeros: taxonomy. (T.D. Macfarlane).	Draft MS prepared of a new species.	Complete MS & submit for publication.
	(h) Dilleniaceae	23	Hibbertia: revision of subsect. Tomentosae in northern Australia. (J.R. Wheeler).	Specimens partially sorted & some critical measurements done; maintained database of label information.	Complete elucidation of taxa & prepare draft MS.
		24	Hibbertia: south-western species. (J.R. Wheeler).	-	Do field studies.

Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
		25	Hibbertia: publication of new taxa. (J.R. Wheeler).	New species of Hibbertia endemic to the Kimberley Region recognized.	Complete MS & submit for publication.
	(i) Droseraceae	26	Description of new taxa. (N.G. Marchant).	Study of relevant related type specimens. Study of morphological variation & distribution. Preparation of descriptions.	Prepare MS.
		27	Revision of infrageneric classification of Drosera. (N.G. Marchant; D. Good, CSIRO).	Data capture. Development of method of computer entry.	Complete data analysis. Publish results & revised infrageneric classification.
	(j) Haemodoraceae	28	Haemodorum: revision. (T.D. Macfarlane).	-	Complete specimen examination, prepare outline of paper.
	(k) Leguminosae: Mimosoideae	29	Acacia sect. Phyllodineae: taxonomy. (B.R. Maslin; A. Chapman).	4 MSS in preparation describing new taxa; preliminary sort of A. ligulata group.	Prepare MSS.
		30	Acacia sect. Plurinerves: taxonomy. (B.R. Cowan).	MS in preparation describing new taxa.	Publish.
		31	Acacia sect. Juliflorae: taxonomy. (B.R. Maslin; R.S. Cowan; A. Chapman).	Application made to Australian Biological Resources Study for funds to undertake project.	Commence description of new taxa.
		32	Acacia: assessment of generic status. (B.R. Maslin; C. Stirton, S. Africa; D.S. Seigler, U.S.A.).	Published data summarized; delivered seminars; paper published.	Prepare MS.
		33	Prosopis: identification of naturalized species. (G. Perry).	Specimens received on loan from N.S.W. and Qld.	Determine natural groups & their affinities for NSW & Qld taxa.
	(l) Leguminosae: Papilionoideae	34	Pultenaea in W.A.: revision. (T.D. Macfarlane).	Completed preliminary DELTA computer-readable descriptions for described taxa.	Resolve taxonomy of difficult species-groups; describe new taxa.
		35	Pultenaea: review of generic limits. (T.D. Macfarlane).	Extensive anatomical preparations made.	Complete data scoring; partially analyse data.
	(m) Loganiaceae	36	Logania: taxonomy. (G. Perry).	-	Annotate AD material.
	(n) Malvaceae	37	Plagianthus alliance: revision. (N.S. Lander).	Paper published (Lawrencia).	Prepare MS describing a new genus & uniting Asterotrichion & Gynatrix.

Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
	(o) Myrtaceae	38	Actinodium: revision. (N.G. Marchant; G.J. Keighery).	Preparation of microscope slides & analysis of morphological structures. Draft descriptions of taxa prepared.	Complete MS & submit for publication.
		39	Agonis: revision. (N.G. Marchant).	Study of type specimens. Study of variation. Study of herbarium collections in MEL.	Prepare draft MS.
		40	Chamelaucium: revision. (N.G. Marchant; G.J. Keighery).	Study of type specimens. Description of recently recognized species. Revision of MS.	Complete MS & submit for publication.
		41	Darwinia: revision. (N.G. Marchant; G.J. Keighery).	Study of Type specimens. Study of variation. Study of herbarium collections in MEL.	Prepare draft MS.
		42	Pileanthus: revision. (N.G. Marchant; G.J. Keighery).	Study of Type specimens. Study of generic limits.	Prepare draft MS.
		43	Generic studies: Definition of generic boundary between Chamelaucium, Darwinia & Actinodium. (N.G. Marchant).	Analysis of morphological data. Study of eastern Australian taxa of Homoranthus & related genera.	Complete
	(p) Poaceae: Pooideae	44	Classification studies. (T.D. Macfarlane).	Paper published.	-
	(q) Proteaceae	45	Grevillea: taxonomy. (K.F Kenneally).	Draft description of a new species prepared.	Complete MS & submit for publication.
	(r) Rutaceae	46	Boronia, Eriostemon: taxonomy (P.G. Wilson).	-	Collect material of the known but undescribed taxa.
	(s) Stylidiaceae	47	Stylidium: taxonomy. (K.F. Kenneally).	Description of a new species completed.	Submit for publication.
	(t) Thymelaeaceae	48	Revision of W.A. taxa. (B.L. Rye).	Paper published.	Continue study of any new material.
	(u) Xyridaceae	49	Xyris: Revision of S.W. species and tropical Australian species. (N.G. Marchant).	Examination of recently collected specimens. Study of related S.E. Asian species in overseas herbaria.	Prepare MS.
	Flora of Australia treatments: (a) Asteraceae: Asteraceae	50	Camptacra (N.S. Lander).	Precursor paper published.	Prepare draft MS.
		51	Kippistia. (N.S. Lander).	-	Prepare draft MS.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		52 Minuria. (N.S. Lander).	Precursor paper published.	Prepare draft MS.
		53 Olearia. (N.S. Lander).	Descriptive & distribution data scored for 17 species for entry into DELTA data base; submitted ABRS application for continuing funding.	Collect data for remaining W.A. species in DELTA system. Record distribution data. Do field studies in SW W.A. Submit ABRS application for continuing funding.
	(b) Asteraceae: Inuleae	54 Helipterum-Helichysum group (P.G. Wilson).	-	Complete MS of the genera Rhodanthe, Pteropogon & Monencyanthes.
		55 Taplinia (N.S. Lander).	Precursor paper in press.	Prepare draft MS.
	(c) Asteraceae: Mutiseae	56 Trichocline (N.S. Lander).	Specimens at BM, DBN, K and TCD examined & data based.	Prepare draft MS.
	(d) Leguminosae: Mimosoideae	57 Acacia sect. Phyllodineae. (B.R. Maslin; A. Chapman).	Flora descriptions prepared.	Complete Flora descriptions & key to species, commence illustrations.
		58 Acacia sect. Juliflorae. (B.R. Maslin; A. Chapman; R.S. Cowan).	Submitted ABRS application for funds.	Commence Flora descriptions; prepare ABRS application for continuing funding.
		59 Acacia sect. Alatae. (B.R. Maslin).	-	Sort.
		60 Acacia sect. Pulchellae. (B.R. Maslin).	-	Sort.
	(e) Leguminosae: Papilionoideae	61 Pultenaea group. (T.D. Macfarlane).	-	Action dependent on completion of precursor projects.
	(f) Malvaceae	62 Plagianthus alliance. (N.S. Lander).	-	Prepare draft MS.
	(g) Myrtaceae	63 Actinodium. (N.G. Marchant.	Draft descriptions prepared.	Prepare MS & submit for publication.
		64 Chamelaucium. (N.G. Marchant G.J. Keighery).	Draft flora description for precursor paper prepared.	Prepare draft MS.
		65 Darwinia. (N.G. Marchant G.J. Keighery).	Preliminary sorting of taxa & field studies.	Prepare draft MS.
		66 Pileanthus. (N.G. Marchant G.J. Keighery).	Preliminary sorting of taxa & field studies.	Prepare draft MS.
	(h) Polygonaceae	67 Polygonum s.str. (G. Perry).	Preliminary grouping of taxa; Type of P. aviculare examined at herb. LINN.	Examine material on loan; compare Australian specimens with material in European herbaria.

Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
	(i) Thymelaeaceae	68	Thymelaeaceae. (B.L. Rye).	Some updating of submitted MS of family treatment & appendix.	Prepare illustrations; submit final updated & corrected MS.
	Flora of NSW treatments: (a) Asteraceae: Astereae.	69	Kippistia. (N.S. Lander)	MS completed, submitted & accepted.	-
		70	Minuria. (N.S. Lander)	MS completed, submitted & accepted.	-
		71	Olearia. (N.S. Lander)	-	Write Flora treatment.
	(b) Asteracea: Inuleae	72	Helipterum. (P.G. Wilson).	MS prepared.	Publish.
	Flora of Central Australia treatments:	73	Numerous taxa. (various staff).	MS submitted & accepted.	-
	Flora of the Kimberley Region.	74	Flora text preparation, editing & co-ordination of project. (J.R. Wheeler).	Prepared Flora descriptions for 10 families, 58 genera & 170 species.	Prepare Flora descriptions for 9 families, 40 genera & 150 species.
				Preliminary editing of 13 families.	Finalize.
				Co-ordination of project.	Continue.
		75	Flora text preparation & editing. (B.L. Rye).	Prepared Flora descriptions for 5 families (comprising about 162 species); preliminary editing of 5 families completed.	Complete descriptions of allocated taxa; continue preliminary editing.
		76	Flora text preparation and editing. (B. Koch).	Prepared Flora descriptions for 3 families (comprising 7 species): additional 2 families comprising 23 species partially completed; preliminary editing of 14 families completed.	Complete descriptions of 8 families comprising 63 species. Continue editing as required.
		77	Flora text preparation of ferns & fern allies, Xyris Drosera. (N.G. Marchant).	Preliminary gathering of data.	Complete treatments.
		78	Flora text preparation of Poaceae & other families.		
		79	Acacia: sort taxa & prepare key to species. (B.R. Maslin).	-	Complete sort & key.
		80	Flora text preparation of Chenopodiaceae. (P.G. Wilson).	-	Complete treatment.

Primary Objective	5 Year Goal		Projects	Tasks Completed 1987/88	Targets 1988/89
		81	New records of Kimberley plants. (K.F. Kenneally; S. Patrick; R.J. 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.	82	Maintain record of corrections, additions, etc. for next edition (N.G. Marchant; J.R. Wheeler).	Developed system for recording corrections, changes & additions to the Flora.	Prepare material for revised edition.
		83	New records of Perth Region plants. (S. Patrick, R.J. 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.	84	Definition of scope of proposed Flora. (N.G. Marchant : flora writers: other staff).	Preliminary development of method of data capture.	Present data to enable informed decision regarding Flora format, boundaries, etc.
	Nomenclatural studies.	85	International Seed Testing Association: 3rd Edition of Stabilized Plant Names. (P.G. Wilson)	New names checked for adding to list.	Check names when received.
		86	Special Committee on Lectotypification. (G. Perry).	Attended IBC, Berlin.	Comment as member of Committee on Lectotypification as required.
		87	Submit proposals to change ICBN for 1993 Tokyo IBC. (G. Perry; J. McNeill, Edinburgh).	Preliminary assessment completed for typification of Lycopersicon esculentum, Amsinckia, Panicum glaucum.	Continue study of nominated taxa.; prepare proposals to change the code.
	Checklist & data base of naturalized flora of W.A.	88	Publication of annotated checklist of the naturalized flora of W.A. (G. Perry).	Researched & modified checklist as necessary.	Continue, with emphasis on Poaceae.
		89	Elucidation of taxonomic problems associated with checklist. (G. Perry).		
		89a	Cytisus proliferus, Hypochaeris, & Lactuca: assess taxonomic status. (G. Perry).	Preliminary assessment conducted.	Do field studies on Lactuca & Hypochaeris.
		89b	Diplotaxis: assess taxonomic status. (G. Perry; J. McNeill, Edinburgh).	Specimens examined at herb. BM, L, LINN; field studies conducted; elucidated application of names.	Continue work on ascertaining correct names for the taxa to which the names D. murale D. tenuifolia are presently applied.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		89c Leontodon: application of species names. (G. Perry).	Library studies completed.	Prepare draft MS.
		89d Medicago murex: typification. (G. Perry).	Type specimen examined at herb. B; draft MS prepared.	Submit for publication.
		89e Paspalum: application of species names. (G. Perry).	Specimen examined at LINN; discussed problems with colleagues at herb. K; draft MS amended.	Submit for publication.
		89f Spergularia: application of species names. (G. Perry; J. McNeill, Edinburgh).	Conducted library studies at BM. Discussions with McNeill.	Examine specimens at herb.
	Phytochemical studies.	90 Cyanogenesis in Acacia subgenus Aculeiferum. (B.R. Maslin; E.E. Conn, U.S.A.; D.S. Seigler, U.S.A.).	MS submitted for publication.	Await proofs.
		91 Cyanogenesis in Acacia pulchella. (B.R. Maslin; E.E. Conn, U.S.A.).	Seed collected; cyanogens analysed.	Prepare for publication.
		92 Wurmbea. (T.D. Macfarlane; J. Bremner, Tasmania; V. Simanek, Czechoslovakia).	Paper published.	Collect further material for collaborators.
		93 Gnephosis. (N.S. Lander; F. Bohlmann, W. Germany; R.M. King U.S.A.).	MS submitted.	Await proofs.
	Evolutionary studies.			
		94 Plagianthus alliance. (N.S. Lander; D.E. Bates, U.S.A).	-	Prepare paper on evolution of Australian & New Zealand species.
	Reproductive biology.	95 Pseudo-chaetochloa: describe dioecy. (T.D. Macfarlane; M. Lazarides, Canberra).	Prepared outline of paper with collaborator.	Complete MS & submit for publication.
		96 Acacia: survey of hybridity. (B.R. Maslin; R.B. Knox, Vic.; J. Kenrick, Vic.; P. Guinet, France).	Draft MS prepared.	Submit for publication.
	Botanical history.	97 Aiton's Hortus Kewensis: author citation. (G. Perry).	Preliminary assessment conducted.	Submit paper for publication.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		98 Brown, R.: Aiton's Hortus Kewensis contribution. (B.R. Maslin).	Specimens at BM & DBN documented; draft MS commenced.	Complete & submit MS.
		99 Consett-Davis, H.F.: Walcott Inlet collections & biography. (K.F. Kenneally).	Additional specimens located in herbarium.	Complete MS.
		100 Cunningham, A.: coastal collecting localities. (S. Curry, B.R. Maslin).	Localities listed, mapped, described; symposium poster paper presented.	Prepare MS.
		101 Cunningham, A.: journal transcriptions. (K.F. Kenneally).	Additional transcribing of journals from microfilm.	Check transcriptions; re-visit Cunningham's Kimberley collecting localities.
		102 Checklist of obscure W.A. historical collecting localities. (N.G. Marchant).	Checklist prepared, localities identified & co-ordinates added.	Prepare MS.
		103 Dorrien-Smith, A.A.: Plant collection from south-west W.A. (K.F. Kenneally).	Accumulate historical records & botanical material related to activities.	Opportunistic.
		104 Fitzgerald, W.V.: diary. (K.F. Kenneally).	Diary edited, entered onto word processor, together with specimen lists.	Examine Fitzgerald specimens at herb. NSW; conduct further genealogical research.
		105 Gardner, C.A.: collecting numbers. (P.G. Wilson).	Paper published.	-
		106 Gould, J./Gilbert, J.: Plant collecting in the Swan River Colony. (K.F. Kenneally).	Locate correspondence & plant collections in overseas herbaria.	Continue to compile data & prepare preliminary MS.
		107 Hochreutiner, B.P.G.: Kimberley Plant Collections (K.F. Kenneally)..	Material sought & received from Geneva. Field work carried out at Broome.	Search records in Battye Library & prepare MS.
		108 Kimberley Plant Collectors. (K.F. Kenneally).	Compile historical dossiers on routes traversed, locate correspondence in relevant libraries and herbaria.	Opportunistic..
		109 Preiss, J.A.L.: Asteraceae specimens collected in W.A. (N.S. Lander).	Paper published.	-
		110 Preiss, J.A.L.: collecting localities. (N.G. Marchant).	Symposium poster paper presented.	Prepare for publication.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		111 Tepper, J.G.O.: 1889 Roebuck Bay collections. (K.F. Kenneally).	Data added to MS in preparation.	Examine Tepper specimens at herb. MEL; finalize MS.
		112 Turczaninow, N.S.: Contribution of Turczaninow to Australian Taxonomy. (N.G. Marchant).	Symposium paper presented.	Prepare for publication.
		113 W.A. Botanists: Checklist of names & collecting localities. (N.G. Marchant).	Checklist updated.	Continue data collection.
	Botanical surveys & species lists: (a) Kimberley			
		114 Dampierland Peninsula survey. (K.F. Kenneally).	Survey continuing; 1100 collections processed, identified & incorporated, field work conducted.	Continue survey & submit for publication.
		115 Vansittart Bay survey. (K.F. Kenneally).	MS, annotated checklist, & maps completed.	Submit for publication.
		116 National Rainforest Conservation Program. (K.F. Kenneally).	Preliminary survey of 90 rainforest patches completed; 1100 collections made, 700 processed, identified & incorporated; specimens checked at DNA.	Continue specimen processing; liaise with B. Hyland (Qld.); visit interstate herbaria.
		117 Walcott Inlet survey. (K.F. Kenneally).	Additional data added.	Complete MS.
		118 Ashmore Reef survey. (K.F. Kenneally).	Additional data added.	Complete MS.
		119 Mitchell Plateau survey. (K.F. Kenneally).	Additions made to checklist.	Continue updating checklist.
		120 Kimberley rivers survey: W.A. Naturalists Club. (K.F. Kenneally).	Identified collections; collated natural history data.	Prepare MS.
		121 Leopold Range: Survey. (P.G. Wilson, R.J. Cranfield, D.G. Goble-Garratt).	Survey conducted.	Process, identify & incorporate collections.
		122 Kimberley flora checklist. (K.F. Kenneally).	Checklist updated as necessary.	Publish checklist.
	(b)South-West			
		123 Wongan Hills. (K.F. Kenneally).	Additional records added to checklist.	Continue updating checklist.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		124 W.A. Dept. Agric. rangeland surveys. (R.J. Cranfield).	Survey of Murchison/Greenough River catchment areas, & Goldfield area.	Process & identify material collected; produce species lists; continue Goldfield survey.
	(c) Pilbara			
		125 List of plants of the Pilbara. (R.J. Cranfield).	Added records to list.	Continue updating list.
Extension and Education.	Provide identification/enquiry service.	126 Provide services as required. (S. Patrick, R.J. Cranfield, all other staff).	As required.	As required.
	Disseminate information on plants of W.A.	127 Toxic legumes of W.A.: revise booklet. (S. Patrick).	Index to species commenced, fluoroacetate content ascertained for some taxa, segregated 4 possibly new taxa.	Commence checking species identity & distribution; collect flowering material of the 4 possibly new taxa.
		128 Prepare information leaflets on the following: Blackboys/Black gins; edible fungi; Angels Trumpet; Grevillea 'Robyn Gordon'; Herbarium garden. (S. Patrick).	Preliminary research commenced.	Continue gathering information
		129 Tree planting on wheatbelt farms : revise leaflets. (S. Patrick).	-	Revise nomenclature & content of existing leaflets, update information.
		130 Kimberley rainforests. (K.F. Kenneally).	Articles published.	-
		131 Acacia: uses for arid/subtropical species. (B.R. Maslin; L. Thompson, Canberra).	Draft MS prepared.	Submit for publication.
	Provide education service.			
		132 Plant identification courses. (S. Patrick; R.J. Cranfield; other staff).	Weekend workshop. Perth & Esperance Wildflower Societies & W.A. Museum.	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; R.J. Cranfield; K.F. Kenneally).	Numerous tours conducted.	As required.

Primary Objective	5 Year Goal	Projects	Tasks Completed 1987/88	Targets 1988/89
		136 Teaching Plant Taxonomy at UWA. (T.D. Macfarlane).	Lecture & practical course presented.	Present 1988 course.
		137 Teaching Plant Taxonomy at Murdoch University. (N.G. Marchant)	Lecture & practical course presented.	Present 1988 course.
		138 Supervision of Ph.D. project on Astroloma. (T.D. Macfarlane; N.G. Marchant; W.A. Loneragan, UWA).	Frequent supervisory meetings held.	Continue supervision as required.
		139 Supervision of Honours project on Stypandra. (T.D. Macfarlane; S.H. James, UWA).	Frequent supervisory meetings held.	Continue supervision as required.
	Review environmental reports & provide conservation advice.	140 Miscellaneous. (Various staff).	Plans reviewed.	As required.
	Produce W.A. herbarium scientific journals.	141 Nuytsia. (N.S. Lander; T.D. Macfarlane; N.G. Marchant; J.W. Searle).	2 issues published; one in press.	Publish 2 issues.
		142 Kingia. (G. Perry; B. Koch; S. Patrick; J.W. Searle.)	One issue published.	Publish 2 issues.

PLANT DISEASES PROGRAM

PROGRAM LEADER

BL Shearer

CURRENT RESOURCES

This program comprises 13.2 persons (3.3 Professional (including 1 contract) + 9.9 Technical (including 1 contract). Its budget is $534 220 ($378 682 salaries, $53 700 wages, $101 838 other).

RESOURCES IN PREVIOUS YEAR

The previous Plant Diseases and Pests Program included some entomology research but did not include research in decay organisms. The resources were: 7.1 CRF + 3.3 funded externally (Professionals: 2.35 + 0.9 funded externally and Technical: 4.75 + 2..4 funded externally); budget $341 945 ($156 000 salaries, $44 700 wages, $141 245 other).

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.

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 1988 TO JUNE 1993 (numbers refer to the Table following)

10,11,13,16,17,19,20,24,26,27,28,29,32,40,42

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

9,23,39,18,38,25,37,34,35,

Together with:

- Importance of *Cryphonectria cubensis.*
- Inoculation methods for Armillaria.
- Production of a video of *P. cinnamomi* impact in native plant communities.
- Reassessment of Podger's dieback sites.

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

6,7

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Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-88	Targets 1988-89
Diagnosis	3,Service	1	Dieback Detection Service	Identify Phytophthora spp	Continue, identify, summarize, publish
	Service	2	Nursery diagnosis	Ongoing service	
	11	3	Cankers in arboretum 73/86	Start survey & analyse	Finish survey and analysis
	11	4	Crown decline in Tuart 49/87	Prepare survey sheets, start	Continue survey
	9	5	Wood rot in Karri	Isolate fungi	Continue pathogenicity tests & identify
	13	6	Survey pine pathogens		New Project : Prepare RPP
	14	7	DNA-wood rot identification	External funds applied for	New Project : Prepare RPP
	Service	8	Diagnosis as problems arise		
Assessment of Damage	3,5	9	P. cinnamomi impact & host range	Data base designed	New Project : Prepare RPP
	6	10	Tree growth, Churchman and Karnet	P. cinnamomi damage in roots assessed	Assess root anatomy
		11	14/84	25 sites assessed	Complete analysis
		12	65/86	MS ready	
		13	50/87	50% sampled	Collect final sample & analyse
	6	14	Jarrah deaths 35/84,43/87	23 areas & 3 blocks assessed	Enter data in INTERGRAPH & analyse. Relate to climatic data.
		15	Aerial	120 000 ha assessed	
	3	16	Distribution & impact of Phytophthora spp. 23/87	Ongoing sampling	Prepare for publication
	10	17	Armillaria in Wandoo 75/86	62 plots assessed and analysed	Write up
	6	18	Growth of Jarrah in low & moderate dieback impact sites	External funds obtained	New Project: : Prepare RPP
Disease Dynamics	2,3	19	Occurrence & rate of spread of Phytophthora spp in woodland 22/87	Sample 8 dead or dying Banksias	Prepare for publication
	2	20	P. cinnamomi population dynamics in woodland 76/87,4/87	5 sites sampled monthly for 1 year	Continue sampling for 2 more years, summarize

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-88	Targets 1988-89
		21	P. cinnamomi dispersal model 74/86,37/87	Simulation model developed	Dispersal experiments, refine model
	2	22	Site hydrology & P. cinnamomi dispersal 23/84	Automated piezometers	Continue measurements
	2	23	P. cinnamomi survival & sporulation	External funds obtained	Fill position New project : Prepare RPPs
	8	24	P. cinnamomi & pine 62/86	Inoculated roots sampled; Inconclusive results.	Terminate
	8	25	P. cinnamomi & pine	Inoculation trials	New Project : Prepare RPP
Disease Management	4		Northern Jarrah P. cinnamomi hazard systems		
		26	System development 40/83	System developed & tested in high rainfall zone	Introduce to operations & publish
		27	Mapping hazard 34/87	6 areas mapped	Select 2 more areas for mapping
	6,4		P. cinnamomi & site water status		
		28	Vegetation water stress 6/85	MS completed	Publish
		29	Hydrological model of Jarrah 64/86	Sites selected & instrumented	
		30	Automated measurement of tree water stress & growth 32/87	Sites selected	Instrument & measure
		31	Thinning & water status	4 sites selected	Select more sites & instrument
		32	Heat pulse 53/87	Abandoned	-
	7	33	Selection of Jarrah resistant to P. cinnamomi 42/85	Inoculation trials completed, analysis in progress	Complete analysis. Prepare for publication
	7	34	P. cinnamomi resistant jarrah clones	Field planting from cloned material	New Project : Prepare RPP
	7	35	Test Jarrah provenances for resistance	Seedlings grown for inoculation	New Project : Prepare RPP Analyse
	7	36	Pinus radiata/ P cinnamomi screening 30/78	Seedlings grown for inoculation	Inoculate, measure
	4	37	Interaction of P. cinnamomi and logging on Jarrah regeneration	Sites selected	New Project : Prepare RPP
	4,6	38	Extension of P. cinnamomi and thinning	External funding obtained	New Project : Prepare RPP

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks Completed 1987-88	Targets 1988-89
	4,6	39 P. cinnamomi extension and water potential	External funding obtained	New Projects : Prepare RPP
Control	1	Phosphorus acid		
		40 Dose response 77/86	Optimal dose determined	Determine changes with time
		41 Conservation areas 72/86	2 areas treated	Monitor mortalities
	1	42 Eradicants 24/87	Plots treated, survival tested	Finish assessing survival

REHABILITATION PROGRAM

PROGRAM LEADER

J R Bartle

CURRENT RESOURCES

This program comprises 15.75 persons (7.95 Professional (including 5 contract) + 7.80 Technical (including 4.8 contract). Its budget is $239 666 ($188 851 salaries, $10 200 wages, $40 615 other).

RESOURCES IN PREVIOUS YEAR

The Program consisted of 8.25 persons (3.55 Professional (including 1 contract) 4.70 Technical (including 2 contract) with a budget of $230 216 ($179 401 salaries, $10 200 wages and $40 615 other). The program has been considerably expanded by the gaining of two Federal Government grants of 3 years, duration enabling the employment of 7.8 extra staff (4.0 Professional + 3.8 Technical) on contract plus supporting funds.

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 or 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 000ha 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 has required a reallocation of research priorities to hasten the improvement of 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.

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.

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 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 600mm 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 1988 TO JUNE 1993
(numbers refer to the Table following)

1(most),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.

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Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Technique Development	Farmland reforestation techniques (Goal 1)	1	Direct seeding		
			44/86	No action	Prepare for publication
			46/86	No action	Prepare for publication
			79/86	Experiment completed	Prepare for publication
			13/87	Experiment completed	No further work planned
			26/87	Experiment completed	Prepare for publication
			28/87	Experiment completed	Prepare for publication
			29/87	Experiment completed	Prepare for publication
			Mullin seeding trial	Analysis proceeding	Complete report
			Main Roads Dept Demonstration	Analysis proceeding	Complete report
			RS35	Analysis proceeding	Further data collection
		2	E. globulus establishment	Successful NAP grant application	New project : Prepare RPPs
		3	E. globulus silviculture	Harvest and growth ring analysis (PhD project) NAP project	Continue harvests and data collection New project : Prepare RPPs
	Saline seep revegetation techniques (Goal 1)	4	Establishment		
			48/86	No action	No action
			70/86	Survival, growth & salinity measurement	Report. Continue measurements
			7/87	"	"
			16/87	Survival & growth measurement	"
			21/87	"	No action
			25/87	"	Report. Continue measurements
			31/87	"	"
			32/87	"	"
			40/87	"	"
			41/87	"	"
			7/88	Commenced	Continue measurements
			8/88	"	"

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		5	Species adaptation		
			49/86	Survival & growth measurement	Report. Continue measurements
			50/86	"	"
			51/86	"	"
			52/86	"	"
			30/87	"	"
			5/88	Commenced	Continue measuremnets
	Minesite revegetation technique (Goal 1)	6	Sands mining		
			RS35	Supervision	Continue supervision
	Species selection/ Genetic improvement (Goal 2)	7	Rehabilitation species trials		
			14/76	No action	Publish growth data to date
			12/78	Monitored groundwater level	"
			31/78	"	"
			52/86	Monitored salt tolerance and growth	Continue data collection
			Pulp species trials	NAP project	New project : Prepare RPP
		8	Genetic improvement 27/80 (globulus)	Performance evaluation Busselton trial converted to seed orchard	Incorporate with other globulus provenance data
			6/81 (wandoo)	Monitored	No action
			24/82 (wandoo)	Growth measurements	Analyse data
			25/82 (wandoo)	"	No action
			38/82 (maculata)	"	Measure growth performance
			40/82 (wandoo)	No action	No action
			38/83 (resinifera)	"	"
			32/84 (globulus)	Performance evaluation	Incorporate with other globulus provenance data
			33/84 (accedens)	No action	No action
			34/84 (camaldulensis)	"	"
			4/86 (accedens)	"	"

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
		5/86 (pilularis)	"	Measure growth performance
		/87 (muellerana)	Established/mortality count	No action
		8/87 (saligna)	"	"
		5/87 (sideroxylon)	"	"
		10/88(microcarpa)	Established winter 88	Do mortality count
		(globulus)	Obtained seed	New project : Prepare RPP/Establish
		(botryoides)	"	"
		(viminalis)	"	"
Technique Development/ Modelling	Land capability/ growth prediction (Goal 3)	9 NAP project	Planning and staffing	New project : Prepare RPPs and establish
Integrated Land/ Catchment Management	Production and conservation benefits (Goal 4)	10 NAP project	"	"
		11 Tacey project	Integrated dieback hygiene into mining operations	Develop procedures for integrated planning of all aspects
		12 Agroforestry		
		264/52	Trees measured	Prepare for publication
		264/54	Trees tended and measured Findings published	Monitor tree growth
		5/81	Trees tended and measurement plots established (P. radiata & P. pinaster)	Monitor tree growth
		10/81	Height & diameter measured, findings reported.	Monitor treegrowth
		43/82	Trees pruned & culled	Establish measurement plots Establish bore holes
		2/87	Busselton & Dinninup - Survival assessed & height measured Middlesex - replanted	Monitor tree growth
		264/53	Stand thinned	Monitor tree growth
		264/51	-	Monitor tree growth
		WSCP grant	Successful application. staff appointed	New project : Prepare RPP

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
	Management of remnant native vegetation (Goal 5)	13 Wandoo decline		
		58/86	Monitoring/completion	No further work planned
		63/86	Terminated	"
		78/86	New leaves tagged/ monitored	Monitor damage
		15/87	Terminated	No further work planned
		56/87	Insect knock down over summer	Continue treatments
		14 Grazing exclusion		
		54/86	Established	Monitor
		15 Regeneration vegetation mapping	-	New Project : Prepare RPP
		Farm demonstrations	-	"
		Regeneration monitoring	-	"
Monitoring	Reconnaissance (Goal 6)	16 List of disturbance problems		New Project : Prepare RPP & commence listings
	Monitoring (Goal 6)	17 Apply monitoring policy	Discuss with other Programs & Divisions	Contribute to implementation of policy.

RESEARCH COMPUTING PROGRAM

PROGRAM LEADER

M Choo

CURRENT RESOURCES

This program comprises 3.6 persons (2.0 Professional + 1.6 Technical). Its budget is $257 142 ($111 832 salaries + $145 310 other).

RESOURCES IN PREVIOUS YEAR

Research methods was previously included in this Program. The Program consisted of 5.8 persons (3.0 Professional + 2.8 Technical) with a budget of $309 650 ($147 650 salaries and $162 000 other).

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.

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 Divison 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). **

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. Provide and maintain an up-to-date information base to satisfy the information processing and retrieval requirements of the Research Division and the Department.

3. Establish a distributed processing network so that corporate information may be readily accessible throughout the divison.

4. Provide facilities and expertise to automate and computerize the functions of statistical analyses, numerical analyses and taxonomy.

5. 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.

6. Facilitate the transfer of information between mainframe and PC word processors and other forms of document storage for consolidation of papers and other documents.

7. 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.

8. 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.

9. Extend and enhance training of Research personnel, conduct training workshops on a regular basis and encourage computer based training.

10. Maintain more full time professional computing staff at the major research centres (Woodvale, 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.

11. Maintain links with the DOCIT trainee scheme.

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 1987-8	Targets 1988-9
Computing Environment	Information management & processing	1	Information Base	Information added to following databases: Animal Ecology Biological Survey Field Data Capture Fire Ecology Fauna Trapping Flora Atlas Flora Conservation Kangaroo Returns Land Management Model Perup Metric Rothermal System Pine Modelling Soil Dryness Index Vegetation Survey Waterbirds Survey Wetland Monitoring Wildflower Returns	Continue to facilitate data updating & provide data management support
		2	Analyses of data	Installation of softwares for statistical & numerical analyses	Continue to provide facilities & train staff to use these sophisticated packages
		3	PC memory upgrades	Upgraded Biogeography Program's NEC to 2mb extended memory for PATN	Get PATN working using extended memory, maintain contact with LAHEY, America.
		4	Obsolescence/ replacement program	-	Work towards replacement of Woodvale DisplayWriter configuration for a PC implementation
				-	Evaluate alternatives for TEK 4054 graphics system, noting implications for FLORAPLOT, GIS and other TEK specific software
		5	Geographical Information System (GIS) for Research Division	Started evaluation of ARC/INFO as a suitable GIS package for Research Division	Continue evaluation of digitizers, TEK 4107 emulation package for PC
					Maintain correspondence with mapping branch & other current users of ARC/INFO
					Organize training sessions at appropriate levels for computing staff & research personnel
				Hold talks with Research Program to rationalize the GIS requirements of Research Division	Evaluate corporate data situation & investigate ways of facilitating addition to CALM's corporate data base.
Training	Interaction with Research Division staff	6	Staff support	Mike Choo visited Como Research once a week	Plan to extend visits to Dwellingup more often
		7	Staff training	Courses presented during the year on dBase III + beginners and intermediate, SAS, LOTUS, DOS, DW3	Start dBase III + advanced workshops & continue other courses on demand
		8	Computing staff	Provided supervision & training for two DOCIT trainees	Continue trainee scheme. Work towards obtaining extra staff for various centres as a matter of urgency.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks Completed 1987-8	Targets 1988-9
Automation	Computerization	9	Electronic Field Loggers, Recorders & Laptops	Acquired more Huskey Hunter computers & develop systems for Biogeography. Also acquired NEC laptops	Continue development of systems for this & other programs. Evaluate NEC and Toshiba laptops for field use
		10	Computer projection panel	Used extensively in training courses and seminars	Continue usage
		11	Systems development	Following systems developed: Expenditure system Numbat Tracking system FPLOT Data Entry system	Continue development & upgrading to suit requirements
		12	Desktop Publishing	Venura Desktop Publishing installed on NEC. Producing documents from DW3, MSW, Multimate etc. Acquired Dataproducts Laser Printer for graphics & documents	Gain further expertise in Ventura operation & share around Research Division
		13	Publication quality output	Now have Ventura, Harvard Presentation Graphics, Laser printer	Work towards producing PC version of camera/video images for various research applications
					Continue to provide various means for producing professional output for presentations and publications
		14	Sound recognition devices	-	Investigate possibilities for use with Biogeography Program's bat data identification using animal calls
Communication		15	Between Computers	Facilitated connection to PIMS, Kangaroo management system, CALM Vax	Continue liaison with Computer Services to maintain links
				Upgraded/maintained communications within Woodvale	Extend to include new PC sites
		16	Word processor communications	Acquired CONVERT. Allows conversion between most word processor formats & Ventura	
		17	Electronic mail	Provided connection to Concurrent NEM electronic mail. Can communicate with other centres via MUX	Extend Communications to CALM Vax mail system

RESEARCH METHODS PROGRAM

PROGRAM LEADER

D Ward

CURRENT RESOURCES

This program comprises (2.5 Professionals + 0.5 Technical. Its budget is $94 394 ($76 744 salaries, $17 650 other)

RESOURCES IN PREVIOUS YEAR

Staff were previously based in the Research Computing Program. The relevant data extracted from this Program are: 1.0 Professional; budget of $92 050 ($74 400 salaries, $17 650 other). Mr M. Williams was appointed as a biometrician in November 1987.

BACKGROUND

The Research Methods Program arose out of the recent review of Research Programs. The needs in scientific research for the application of methods such as experimental and survey design, statistical analysis, and mathematical modelling are so familiar that they need no further discussion here.

AIM

To ensure correct experimental design, data analysis and modelling, and to explore new methods for synthesizing research information into a form useful for conservation and land management.

PRIMARY OBJECTIVES

Research design
To help researchers define more clearly the system that they are studying, their objectives 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 methods 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, where necessary, raise standards of experimental and survey design.

2. Maintain and, where necessary, raise standards of data analysis.

3. Encourage use of mathematical modelling.

4. Explore the application to the above tasks of various branches of logic including mathematical, graphical, cybernetic and structured linguistic techniques.

Primary Objectives	Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Research design and data collection	34/87 to 56/87 1/88 to 18/88 See Appendix II	All these designs vetted for validity. Consultation in some cases (D. Ward & M. Williams)	Check all RPPs for design validity.
Analysis and Synthesis	16/58 Pine Growth Trial	Analysis (M. Williams)	E. Hopkins to write up.
	3/71, 4/71 Fire effect on scrub.	Analysis (D. Ward)	P. Christensen to write up.
	8/71 Effect of fire on mardo.	Analysis & modelling (D. Ward)	M. Mason to write up.
	32/83 S.Jarrah veg. types.	Analysis, modelling & program for HUSKY (D. Ward)	G. Strelein to write up.
	32/85, 59/86 Tryphocaria study.	Analysis (M. Williams)	More analysis. I. Abbott to write up.
	15/87 Wandoo decline	Analysis (M. Williams)	More analysis. P. Brown to write up.
	50-53/88 Jarrah water relations	Analysis (M. Williams)	S .Crombie to write up.
	20/85 Microclimate study.	Analysis (M. Williams)	C. Portlock to write up.
	None of the following has an RPP No. allotted.		
	RAOU waterbird survey.	Analysis (D. Ward)	Further analysis. S. Halse to write up.
	Yanchep NP visitor survey	Analysis & summary (D. Ward)	I. Herford to produce Management Plan.
	Bungle-Bungle NP visitor survey	Analysis & summary (D. Ward)	M. Colreavy to produce Management Plan.
	Fitzgerald NP visitor survey.	Analysis (D. Ward)	Further analysis. S. Moore to produce Management Plan.
	Vegetation density assessment method.	Program written for HUSKY. Some field testing. (D. Ward)	Further field testing with Inventory branch and ALCOA. D. Ward to write up.
	Taxonomy of ecological interactions. (Ecocube & Question mapping)	Fundamentals established (D. Ward)	Fine tuning. D. Ward to write up.
	Conservation status of W.A. mammals.	Analysis (D. Ward)	N. McKenzie & A.A. Burbidge to write up.
	SAS Training	Introductory course (M. Williams)	Arrange further courses.
	Multivariate analysis training	Course run by Dr G. Riley of SIROMATH (D. Ward)	Arrange further taining if needed

SILVICULTURE PROGRAM

PROGRAM LEADER

J McGrath

CURRENT RESOURCES

The program comprises 23.45 persons (4.45 Professional + 16.00 Technical + 3.00 Wages). Its budget is $893 502 ($595 277 salaries, $96 570 wages, $201 655 other).

RESOURCES IN PREVIOUS YEAR

Research covered by the Silviculture Program was previously carried out in the Jarrah Forest, Karri Forest and Pine Programs.

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.

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 propogation 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 1988 TO JUNE 1993
(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; Thinning and Fertilization of Karri : 10; Drought deaths in pine : 3; South coast *P. radiata* fertilizer requirements : 12; Jarrah Regeneration techniques : 9; Seed production and cuttings propogation 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 1987/88

BARTLE, J.R. & STONEMAN, G.L. (1987). Mining and hydrology in the jarrah forest. In: Institute of Foresters of Aust. Conference 1987 : 25-28

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*BORG, H., STONEMAN, G.L. & WARD, C.G. (1988). The effect of logging and regeneration on ground water, streamflow and stream salinity in the southern forest of Western Australia. J. Hydrol. 99 : 253-270.

*BRENNAN, R.F. & McGRATH J.F. (1988). The vertical movement of zinc on sandy soils in southern Western Australia. Aust. J. Soil Res. 26 : 211-216.

*STEERING COMMITTEE FOR RESEARCH ON LAND USE AND WATER SUPPLY (1987). Forest management to increase water yield from the northern jarrah forest. Water Authority of Western Australia, Report No. WS 3, 23 pp. (Authored by Schofield, N.J., Bartle, J.R. & Stoneman, G.L.).

STONEMAN, G.L. (1987). Effect of thinning regrowth jarrah stands on stand leaf area and growth. In: Management of Water and Nutrient Relations to Increase Forest Growth. International Union of Forest Research Organization, Conference Proceedings.

*STONEMAN, G.L., ROSE, P.W. & BORG, H. (1988). Recovery of forest density after intensive logging in the southern forest of Western Australia. CALM Tech. Rep. No. 19.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
Site Classification	Jarrah site classification	1	Jarrah site classification project 23/83	In press	-
	Karri site classification	2	Karri site classification 19/86	Drafts prepared	Finalize publication
			9/88	RPP prepared Mapping commenced.	Map community types in 5 blocks
	Pine site classification	3	Drought Survey of Blackwood Valley	New Project	Prepare RPP. Commence survey
Stand Management	Jarrah stand management	4	Thinning and Fertilization 2/88	Plots fertilized Autumn 88 Water relations measurements commenced Autumn 88 L.A.I. measurements spring, autumn. Install neutron access holes, through fall & stem flow equipment.	Continue measuring L.A.I. Continue soil and tree moisture measurements. Install soil monitoring equipment.
			Compare effectiveness of nitrogen fixation by native legumes with nitrogen fertilization on jarrah growth.	New Project	Prepare RPP
		5	Thinning Responses and Growth Rates 49/65	No Action (Maintenance)	No Action
			15/66	No Action	No Action
			17/83	No Action	Evaluate growth responses
			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 1/77	Silvicultural survey of Jones & Higgins catchments; Treated Jones catchment	Thin Higgins catchment Monitor all catchments in study

Primary Objectives	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
		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	Compared four different measurement techniques; 2 papers prepared	Publish papers Evaluate remote sensing techniques
	Jarrah thinnng techniques	8 Chemical Thinning of Jarrah		
		37/84	Results summarized. Further experiments established	Establish further herbicide experiments
		34/85R35/85	"	"
		36/85	"	"
		37/85	"	"
		39/85	"	"
		40/85	"	"
		41/85	"	"
		30/86	"	"
		31/86	"	"
	Jarrah regeneration	9 Regeneration Techniques		
		24/80	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 stand management		
		21/77	Drafts prepared.	Publish papers
		15/82	Measurement & maintenance	
		3,84	Measured, maintained, data analysed, drafts prepared	Publish paper
		25/85	Measurement & maintenance	No action
		Thinning and fertilization in regeneration karri	New project	Prepare RPPs & commence experiment establishment
	P. radiata nutrition	11 Nutrition of young radiata		
		9/82	See 1/85	-
		19/82	Data collected, Growth measurements continued	Evaluate, maybe terminate

Primary Objective	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
		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
		16/85	Paper prepared (In press)	
		17/85	Sampling measurement & nutrient analyses continued	Analyse data.
		33/87	72 plots established & fertilized	Measure & evaluate.
		18/88	80 plots established & fertilized at Albany	Measure annually
		12 Nutrition of older radiata and nutrition x fertilizer interactions		
		8/85	Progress report prepared. Measurement of 50 plots continued	Continue annual measurements
		9/87	24 Plots established & measurements commenced	Continue measurements
		10/87	"	"
		11/87	12 Plots thinned, fertilized, Neutron access probes installed. 60 sample trees selected & marked	Commence routine monitoring. Replicate on other site types.
		Fertilizer requirements on the south coast	New Project	Prepare RPP
		Tissue analysis in older trees	New project	Prepare RPP
	P. radiata stand management	13 Plantation silviculture		
		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
		45/82	Pruning carried out. Height & diameter measured	Continue annual measurements

Primary Objective	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
		3/83	Pruning treatments carried out. Height & diameter measured	Continue annual measurements
		6/83	Height & diameter measured	Collate, analyse & report results
		7/83	Height & diameter measured	Write progress report
		28/83	Height & diameter measured	Analyse data & write progress report
		30/83	Height & diameter measured	Measure particle board volume (age 9)
		17/84	Thin, prune & fertilize	-
		14 Agroforestry		
		15/73	Trees measured	Monitor tree growth
		10/75	Tree growth measured	Monitor tree growth
		2/78	Height & diameter measured	Monitor tree growth
		4/80	Trees high pruned. tree growth measured	Collate & analyse data
		1/86	Survival & height reassessed	Terminate
		2/86	Trial replanted. Survival assessed	-
	Comparison of species performance	15 Arboreta & species trials		
		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	
	P. pinaster stand management	16 P. pinaster silviculture and hydrology		
		16/58	Study completed	Prepare for publication
		20/65	Study completed	Collate data; plan utilization study
		48/66	Fertilizer treatments applied in August 1987	Continue annual measurements
		17/67	Heights & diameters measured in February 1988	Continue annual measurements

Primary Objective	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
		54/66	Study completed	Collate data, plan utilization study
		20/68	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 in April 1988	Thinning treatments
		23/73	Heights & diameters measured in March 1988	Continue annual measurements
		20/75	Heights & diameters measured in February 1988.	Thinning treatments
		20/76	No action	Process data & review
		21/76	Heights & diameters measured in February 1988	Continue annual measurements
		22/76	Heights & diameters measured in February 1988	Continue annual measurements
		26/80	No action	Process data and review
		2/81	No action	Process data for publication
		25/83	Establishment measure & culling in March 1988	Put in fertilizer treatments
		29/83	No action	Process data
Tree Breeding	Jarrah genetic diversity 17	Genotypic variation in Jarrah		
		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		
		RS 28	Initial surveys of genetic variability completed	Publish data. Investigate mating systems
		26/78	No action	Measure & index selection
		Seed production	New project	Prepare RPP
		Cuttings propagation of Karri	New project	Prepare RPP

Primary Objective	5 Year Goals	Projects (RPP No.)	Tasks completed 1987-88	Targets 1988-9
	Pine breeding	19 P. pinaster genetics		
		3/65	Drafts prepared	Finalize publication
		21/65	Assessment, second generation selection	Revise breeding plan
		20/72	Data collated	Prepare for publication
		20 P. radiata genetics		
		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		
		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

PROGRAM LEADER

J Lane

CURRENT RESOURCES

This program comprises 3.4 persons (1.7 Professional + 1.7 Technical). Its budget is $195 056 ($129 246 salaries, $65 810 other).

RESOURCES IN PREVIOUS YEAR

3.55 persons (1.7 Professional + 1.85 Technical); budget of $226 456 ($158 346 salaries, $68 110 other).

BACKGROUND

For historical reasons the Program was, until 1986, concerned primarily with the collection of data needed:

i) to identify the conservation value (principally as waterbird habitat) of specific wetlands and thereby to assist in the struggle to protect these habitats from degradation and inappropriate forms of development or use, and

ii) to facilitate responsible management of annual duck hunting seasons.

A number of small studies directed towards the resolution of specific management issues were also conducted. Program members were also much involved in wetland reservation, management, management planning, policy issues and resolution of conflicts.

With the formation of CALM and the structural separation of research, management, management planning and policy functions into different Divisions, the Program has attempted to increase its emphasis on research and to be less involved in other functions which are properly the responsibility of other branches.

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 entrophication.**

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 wet lands.

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.

PROJECTS TO BE COMPLETED FROM JULY 1988 TO JUNE 1993
(numbers refer to the Table following)

1-4,8,9,11-16,18

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

1. Annual assessment of waterfowl abundance. Joint CALM/RAOU-volunteers project with counts each November and March. This is an expansion of the Great Duck Count.

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

1. Waterbird usage of wetlands of Swan Coastal Plain. Joint CALM/WAWA project using RAOU volunteers to assess the significance of different types of wetland for waterbirds to assist in planning the exploitation of Perth's groundwater resources.

2. 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.

PUBLICATIONS* AND REPORTS 1987/88

*BARTLE, J., GRAHAM, G., LANE, J.A.K. & MOORE, S.A. (1987). Forrestdale Lake nature reserve management plan. CALM Management Plan No. 3 (122 pp)

*HALSE, S. (1987). Probable effect of salinity on the waterbirds of Lake Toolibin. CALM Tech. Report No. 15. (31 pp.)

*HALSE, S.A. (1988). The last lake. *Landscope* 3:17-22.

*HALSE, S.A. & HALSE, N.J. (1988). Seabirds and shorebirds at Ningaloo in winter, with comments on Hutton's Shearwater. W. Aust. Nat. 17:97-106.

HALSE, S.A. & WARD, D. (1987). Assessing conservation value of wetlands. Abstracts of 26th Congress, Australian Society for Limonology. Aust. Soc. Limnology Newsletter 25:36

*WATKINS, D.W., CLARKE, J., LANE, J.A.K. & MOORE, S.A. (1987). Benger Swamp nature reserve mgmt plan. CALM Management Plan No. 7 (92 pp.)

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Wetland Values	Remote wetlands	1	Kimberley surveys	Fitzroy River, lower Ord R. & Lake Argyle surveys	No further research planned
	Seasonal usage	2	South west surveys	Wonnerup, Vasse monitored	New project : Prepare RPP
		3	Waterbird use of Wetland Nature Reserves	Final draft prepared	Publish
		4	Waterbird use of wetlands of Swan Coastal Plain	Project outline prepared (joint project with WAWA)	New project: Obtain funding commitment & prepare RPP
	Invertebrate conservation status	5	Ostracod taxonomy	Descriptions of 1 new genus, 3 new spp prepared for publication	Describe new spp as found
		6	South-west surveys	34 wetlands sampled, 1 two-monthly, some analysis	Do limited no. of surveys, continue analysis
Status of Waterbird Populations	Annual abundance	7	March counts	March '88 count conducted	New project : Prepare RPP
	Duck banding	8	Analysis of historical data	Analysis completed	Prepare for publication.
	Egret colonies	9	Location, size & numbers	Colonies monitored	Prepare for publication.
Wetland Ecosystem Dynamics	Wetland monitoring	10	Sept & Nov surveys	Sept & Nov 1987 surveys undertaken	Do Sept & Nov 1988 surveys
	Environmental parameters	11	RAOU waterbird survey analysis	Vegetation data collected	Finish analysis & prepare for publication.
	Impact of Mosquito Control	12	Leschenault Inlet	Invertebrate analysis completed, most bird fieldwork finished	Finish fieldwork, analyse & prepare for publication.
	Ducks & salinity	13	Breeding success in SW	None	Do fieldwork at 2 sites
	Food selection	14	Diet in fresh water	30 birds collected & invertebrates sampled	Continue fieldwork
	Midge nuisance control	15	Midge Research Steering Committee	Funding obtained, short term control options evaluated	Evaluate long term control options
	Herdsman pesticides	16	Organochlorines in swamphens	Fieldwork & analysis completed	Prepare for publication.
	Wetland Vegetation	17	Longterm monitoring	Fieldwork, mapping & vegn structure completed	Finish identifications & prepare for publication
	Lead shot	18	Gizzard contents analysis	Analysis	Prepare for publication.

WOOD UTILIZATION PROGRAM

PROGRAM LEADER:

GR Siemon

CURRENT RESOURCES:

The program comprises 5.9 persons (2.4 Professional + 3.5 Technical (including 1 contract). Budget is under the control of the Division of Forest Resources.

RESOURCES IN PREVIOUS YEAR:

Staff (3.0 Professional + 2.0 Technical) were divided among the Jarrah Forest, Karri Forest, Pine and Rehabilitation programs.

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 the Senior Principal Research Scientist (Management)), reviews the research program quarterly.

The Department has an ongoing commitment to wood utilization research.

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 State's 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 of the log resource prior to processing.

3. Study techniques of log conversion best suited to converting regrowth eucalypts to high value timber.

4. Assist in the validation of the Australian Timber Research Institute's seasoning models by collecting relevant data on W.A. species.

5. Develop efficient initial curing schedules and commercial equipment which will allow subsequent defect-free drying to be carried out.

6. Establish efficient schedules and develop commercial equipment for drying timber from regrowth eucalypts.

7. Quantify the physical and mechanical properties of hardwoods and softwoods.

8. Study the wood destroying organisms which are of commercial significance in reducing the value of timber from regrowth eucalypts.

9. Develop a computer model of the forest products industry to facilitate efficient management of the forest resource.

10. Identify target markets with needs which could be supplied by timber from regrowth eucalypts.

11. Develop processes to meet the needs of target markets in obtaining added-value products.

12. Test the suitability of regrowth eucalypt residues for potential markets.

13. Analyse established and potential markets for residues.

PROJECTS TO BE COMPLETED FROM JULY 1988 TO JUNE 1992 (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

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

Wood quality and staining in Karri

PUBLICATIONS * AND REPORTS
(Small Eucalypt Processing Study)

*BRENNAN, G.K. (1988). Assessment of five different watering regimes for regrowth jarrah log stockpiles.
Penetration of copper-chrome-arsenic preservative into regrowth jarrah posts.
Logging and stockpiling regrowth jarrah logs and pre-drying 25mm boards.
Economic utilisation of thinning from the jarrah forest. WURC Report No.1.

*BRENNAN, G.K. & DOUST, B.R. (1988). Moisture content of jarrah logging residues. WURC Report No. 3.

*BRENNAN, G. (1988). End splitting of W.A. sheoak *(Allocasuarina fraseriana)* logs stored under water spray or dry stockpiled. Seasoning 25mm boards of mature jarrah using a progressive tunnel kiln. WURC Report No. 5.

*CLARKE, J. & BRENNAN, G. (1988). Small jarrah sawlog and residue log harvesting trials near Harvey, W.A. WURC Report No. 4.

*CREFFIELD, J.W. BRENNAN, G.K. & CHEW, N. Susceptibility of air dried and high temperature dried regrowth karri *(Eucalyptus diversicolor)* to attack by the powder post borer *(Lyctus brunneus)*. Progress Report No. 1. CSIRO Division of Forestry and Forest Products)

GLOSSOP, B. Assessment of Viva - 20 capacitance type moisture meter.

GREENHALGH, R. (Consultant) The use of ultrasonics for moisture content determination.

*MCKENZIE, W.M. (Consultant) (1988). Report on sawing performance in Western Australian sawmills. WURC Report No. 2

NORTON, M.P. (Consultant) A literature review of the uses of ultrasonic applications for timber processing.

SIMPSON, L. (Consultant) Starch depletion rates in karri sapwood.

WHITE, K.J. Sawmilling of regrowth karri logs.

WHITTAKERS RESEARCH (Consultant) A model of the timber industry.

OTHER REPORTS

CHALLIS, D. Pine as a building material.

DONNELLY, D.J., MATHEWS, L.R. & HANKS, W.R. High temperature drying of green jarrah blocks prior to charcoal production.

RULE, R. The Wickepin fence post - 1987 inspection.

SIEMON, G. Using pine timber.

SIEMON, G. & DONNELLY, D. Graded recoveries of timber milled from radiata pine logs from different thinning treatments.

SIEMON, G., WHITE, K. & THOMSON, A. Sawmilling trial of agroforestry and conventionally-grown radiata pine.

THOMSON, A.B. Moisture loss in small jarrah firewood billets.

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
S.E.P.S. Sawmilling	Protection prior to processing	1	Stockpiling		
			18/85	Report completed	-
			8/86	Report completed & ready for publication	Publish
			19/88	RPP approved	Commence study
	Techniques of conversion	2	Sawmilling		
			7/86	Milling completed	Prepare report
			71/86	Milling completed	Prepare report
			18/87	Milling completed	Prepare report
			17/88	RPP approved	Commence study
Seasoning	Developing efficient drying schedules	3	Seasoning 27/85	Report completed	Publish
	Developing efficient drying schedules		28/85	Report on jarrah completed	Season karri and marri (low priority)
			9/86	Report completed (CSIRO liaison)	
			6/88	Research commenced	Ongoing
			14/88	Research commenced	Ongoing
Wood Properties	Quantify physical and mechanical properties	4	Strength 26/86	Initial tests completed (Curtin Univ. co-operation)	Ongoing - sample for more tests
		5	Durability 41/86	Specimens forwarded to CSIRO	Ongoing
		6	Wood quality (submitted)	Brown wood study in Karri continued	Ongoing
		7	Density 6/88	Data collection on wood density & moisture contents commenced	Ongoing
Product Development	Develop processes for added-value products	8	Product development 26/84	Report completed for publication	Publish
	Market research		(Submitted)	Commenced WA furniture timber market survey	Ongoing
			16/88	Study commenced	Complete study
Residues	Suitability of regrowth residues for markets	9	Residues	Drying rates of firewood	-
Mature Hardwoods	Quantify physical properties	10	Mature hardwoods 29/84	Report completed	Publish
	Developing efficient drying schedules		30/84	Report completed	-
			31/84	Report completed	-

Primary Objectives	5 Year Goals		Projects (RPP No.)	Tasks completed 1987-8	Targets 1988-9
Softwoods	Quantify physical properties	11	Softwoods 30/82	Wood density assessment continued	Ongoing sampling from geographic range
	Techniques of conversion		42/86	Report finished for publication	Publish
			21/88	Logs stocked for sawmilling shed	Carry out study
	Develop process for added-value products		15/88	RPP approved	Carry out study

Appendix I
Allocation of Staff to Programs

Abbreviations		
	DMR	Divisional Manager Research
	SPRS	Senior Principal Research Scientist
	PRS	Principal Research Scientist
	SRS	Senior Research Scientist
	RS	Research Scientist

N.B. Source of funding is from Consolidated Revenue Funds (CRF) unless otherwise indicated.

EXECUTIVE AND ADMINISTRATIVE SUPPORT

Professional Total = 5.15

A.A. Burbidge (Program Leader)	DMR	Woodvale	75%
I. Abbott	PRS	Como	40%
J. Bartle	PRS	Como	30%
N. Burrows	SRS	Woodvale	10%
P. Christensen	SPRS	Como	80%
D. Coates	SRS	Woodvale	10%
S. Hopper	SPRS	Woodvale	60%
J. Lane	PRS	Woodvale	30%
L. McCaw	RS	Manjimup	20%
J. McGrath	SRS	Como	40%
N. McKenzie	SRS	Woodvale	10%
R. Moore	SRS	Busselton	10%
R. Prince	SRS	Woodvale	20%
B. Shearer	SRS	Dwellingup	20%
G. Siemon	PRS	Como	10%
A. Start	PRS	Woodvale	50%
Curator	SPRS	Herbarium	30%

Technical & Clerical Total (CRF) = 16.50

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%
V. Hamley	Herbarium	100%
R. Hick	Woodvale	100% (of 3 days/week = 60%)
J. Imms	Woodvale	100%
P. Jenkins	Busselton	10%
G. Maranta	Dwellingup	100%
C. Mathews	Woodvale	100%
S. McArthur	Como	50%
D. Munro	Woodvale	10%
G. Pearson	Woodvale	20%
M. Pree	Manjimup	100%
J. Pryde	Woodvale	100%
B. Read	Busselton	10%
J. Rooney	Manjimup	20%
L. Simmonds	Manjimup	100%
R. Sokolowski	Woodvale	10%
J. Stritof	Wanneroo	10%
H. Warren	Dwellingup	100%
M. Wilke	Como	100%
A. Williams	Woodvale	10%
L. Wong	Como	100%

EXTERNALLY FUNDED

G. Godfrey	Como	100%

BIOGEOGRAPHY

Professional **Total =** **3.65**

N. McKenzie (Program Leader)	SRS	Woodvale	85%
A.A. Burbidge	DMR	Woodvale	5%
A.H.Burbidge	RS	Woodvale	80%
A. Hopkins	SRS	Woodvale	25%
G. Keighery	SRS	Woodvale	80%
K. Morris	RS	Woodvale	40%
G. Wardell-Johnson	RS	Manjimup	50%

Technical **Total =** **3.6**

J. Alford		Woodvale	80%
T. Annels		Manjimup	50%
P. Fuller		Woodvale	10%
G. Liddelow		Manjimup	50%
J. Rolfe		Woodvale	80%
C. Vellios		Manjimup	50%
I. Wheeler		Manjimup	40%

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%
W. Frost (temp)		Manjimup	100%
P. Skinner		Manjimup	100%
P. Van Heurck		Como	100%

FAUNA CONSERVATION

Professional **Total =** **4.4**

R. Prince (Program Leader)	SRS	Woodvale	80%
D. Algar	RS	Woodvale	50%
A.A. Burbidge	DMR	Woodvale	5%
A.H. Burbidge	RS	Woodvale	15%
J. Friend	SRS	Woodvale	100%
J. Kinnear	SRS	Woodvale	100%
N. McKenzie	SRS	Woodvale	5%
K. Morris	RS	Woodvale	60%
D. Pearson	RS	Kalgoorlie	20%
A. Start	PRS	Woodvale	5%

EXTERNALLY FUNDED

D. Algar		Woodvale	50%

Technical **Total =** **4.7**

B. Bromilow (wages)		Woodvale	100%
P. Fuller		Woodvale	50%
T. Leftwich		Woodvale	100%
M. Onus		Woodvale	100%
J. Rolfe		Woodvale	20%
A. Williams		Woodvale	90%
I. Wheeler		Manjimup	10%

EXTERNALLY FUNDED

N. Thomas	Woodvale	100%	

FIRE

Professional **Total =** **5.35**

N. Burrows (Program Leader)	SRS	Woodvale	90%
P. Christensen	SPRS	Manjimup	20%
A.A. Burbidge	DMR	Woodvale	10%
G. Friend	SRS	Woodvale	100%
A. Hopkins	SRS	Woodvale	60%

L. McCaw	RS	Manjimup	80%
D. Pearson	RS	Kalgoorlie	80%
A. Start	PRS	Woodvale	45%
G. Wardell-Johnson	RS	Manjimup	50%

Technical **Total = 10.45**

T. Annels	Manjimup	50%
P. Fuller	Woodvale	35%
J. Harvey	Woodvale	100%
G. Liddelow	Manjimup	80%
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%
Vacant	Kalgoorlie	80%

FLORA CONSERVATION

Professional **Total (CRF) = 1.55**

D. Coates (Program Leader)	SRS	Woodvale	85%
A.A. Burbidge	DMR	Woodvale	5%
A.H. Burbidge	RS	Woodvale	5%
S. Hopper	SPRS	Woodvale	40%
G. Keighery	SRS	Woodvale	20%

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%)
S. Van Leeuwen	Woodvale	100%

Technical **Total = 2.15**

J. Alford	Woodvale	20%
A. Brown	Woodvale	100%
P. Fuller	Woodvale	5%
R. Sokolowski	Woodvale	90%

HERBARIUM

Professional **Total (CRF) = 10.70**

Curator (Program Leader)	SPRS	70%
K. Kenneally	Botanist	100%
B. Koch (part-time)	Botanist	100% (of 2.5 days/week = 50%)
N. Lander	Botanist	100%
T. Macfarlane	Botanist	100%
N. Marchant	Snr.Botanist	100%
B. Maslin	Snr.Botanist	100%
S. Patrick	Botanist	100%
G. Perry	Botanist	100%
B. Rye (part-time)	Botanist	100% (of 2.5 days/week = 50%)
J. Wheeler	Botanist	100%
P. Wilson	Snr.Botanist	100%

EXTERNALLY FUNDED

A. Chapman (part-time)	100% (of 2 days/week = 40%)
R. Cowan (part-time)	100% (of 3 days/week = 60%)

Technical **Total (CRF) = 5.00**

R. Cranfield	100%
T. Lally (temp.)	100%
C. Parker (part-time)	100% (of 2.5 days/week = 50%)
P. Rokick (Gardener - wages)	100%
J. Searle (part-time)	100% (of 2.5 days/week = 50%)
P. Spencer	100%

EXTERNALLY FUNDED

S. Curry	100%
J. Rainbird (part-time)	100% (of 2.5 days/week = 50%)

PLANT DISEASES

Professional **Total (CRF) = 2.3**

B. Shearer (Program Leader)	SRS	Dwellingup	80%
E. Davison	SRS	Como	50%
M. Stukely	RS	Como	100%

EXTERNALLY FUNDED

S. Crombie		Como	100%

Technical **Total (CRF) = 8.9**

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	60%
J. Webster		Dwellingup	100%

EXTERNALLY FUNDED

F. Bunny		Como	100%

REHABILITATION

Professional **Total (CRF) = 2.95**

J. Bartle (Program Leader)	PRS	Como	70%
P. Brown	RS	Narrogin	100%
T. Butcher	RS	Como	20%
A. Hopkins	SRS	Woodvale	15%
R. Mazanec	RS	Dwellingup	40%
R. Moore	SRS	Busselton	50%

EXTERNALLY FUNDED

D. Bicknell		Esperance	100%
G. Ellis		Bunbury	100%
B. Mattinson		Como	100%
P. Ritson		Collie	100%
R. Silberstein		Bunbury	100%

Technical **Total (CRF) = 3.00**

T. Birmingham		Dwellingup	40%
P. Jenkins		Busselton	50%
M. Mason		Dwellingup	40%
D. McDonald		Narrogin	100%
B. Read		Busselton	30%
C. Sanders		Wanneroo	20%
J. Stritof		Wanneroo	20%

EXTERNALLY FUNDED

D. Bennett		Bunbury	100%
T. Duncanson		Bunbury	100%
N. Pettit		Collie	100%
J. Spice		Bunbury	100%

D. Vincent			Esperance	100% (of 4 days/week = 80%)

RESEARCH COMPUTING

Professional Total = 2.0

M.Choo (Program Leader)		Woodvale	100%
P. Gioia		Woodvale	100%

Technical Total = 1.6

P. Walsh		Manjimup	100%
K. Whitford		Dwellingup	10%
Y. Woods		Manjimup	50%

RESEARCH METHODS

Professional Total = 2.00

D. Ward (Program Leader)		Como	100%
M. Williams		Como	100%

Technical Total = 0.50

Y. Woods		Manjimup	50%

SILVICULTURE

Professional Total = 4.45

J. McGrath(Program Leader)	SRS	Como	60%
T. Butcher	SRS	Como	80%
D. Coates	SRS	Woodvale	5%
P. Hewett	RS	Manjimup	100%
R. Mazanec	RS	Dwellingup	60%
R. Moore	SRS	Busselton	40%
G. Stoneman	RS	Dwellingup	100%

Technical Total = 19.00

S. Bellgard		Dwellingup	100%
T. Birmingham		Dwellingup	60%
J. Bopp		Busselton	100%
G. Calvert		Wanneroo	100%
M. Cully		Como	40%
I. Drumbell		Busselton	100%
I. Freeman		Dwellingup	100%
R. Giles		Dwellingup	70%
B. Hingston		Busselton	100%
P. Jenkins		Busselton	60%
H. Karchevchi (Wages)		Busselton	100%
M. Mason		Dwellingup	60%
S. McArthur		Como	50%
C. Portlock		Dwellingup	100%
B. Read		Busselton	60%
J. Rooney		Manjimup	80%
C. Sanders		Wanneroo	80%
J. Schuts (Wages)		Busselton	100%
J. Stritof		Wanneroo	70%
C. Ward		Manjimup	100%
K. Whitford		Dwellingup	90%
A. Wills		Como	100%
A. Woodward (Wages)		Busselton	100%

WETLANDS AND WATERBIRDS

Professional Total = 1.7

J. Lane (Program Leader)	PRS	Woodvale	70%
S. Halse	SRS	Woodvale	100%

Technical Total = 1.7

D. Munro		Woodvale	90%
G. Pearson		Woodvale	80%

WOOD UTILIZATION

Professional **Total =** **2.40**		
G. Siemon (Program Leader)	Como	90%
G. Brennan	Bunbury	100%
E. Davison	Como	50%
Technical **Total (CRF) = 2.5**		
B. Glossop	Harvey	100%
F. Tay	Como	50%
A. Thomson	Harvey	100%
EXTERNALLY FUNDED		
W. Hanks	Harvey	100%

Appendix 11

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.

Active Research Project Plans for the Herbarium can therefore not be listed in this edition of the Research Plan.

** indicates RPP No. not allocated*

RPP No	TITLE	PRINCIPAL INVESTIGATOR
BIOGEOGRAPHY		
15	Ecological Survey of Southern Beekeepers Reserve	A.H.Burbidge
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 et al
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 Boonanaring Reserve	A.H.Burbidge & G.Keighery
120	Extending the Nullarbor data base: do the patterns change?	N.McKenzie et al.
121	Assemblage changes over 12 months at Cocklebiddy	N.McKenzie et al.
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 (consultancy let by)	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 & Carnarvon districts, Western Australia (consultancy let by)	N. McKenzie
127	Fitzgerald River National Park Survey-F.R.N.P.S. Association consultants	N.McKenzie
128	Buccaneer Archipelago	N.McKenzie et al.
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
132	Dampier Archipelago Management Plan	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
*	Salisbury Island	A.A.Burbidge et al.
*	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 vertebrae fauna of the northern Irwin and southern Carnarvon districts. Consultancy let by	A.H.Burbidge (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 et al.
*	Yanchep National Park Survey	A.H.Burbidge
*	Walpole-Nornalup National Park survey	G.Wardell-Johnson
*	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 et al.
*	Buccaneer Archipel. Management Plan	R.Prince

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
*	Perup Priority Area Survey	G.Wardell-Johnson
*	Bat assemblage structure studies disturbance and determinism	N.McKenzie
*	Vegetation of Dryandra State Forest (consultancy let by)	G.Keighery
*	Recherche Monitoring Sites	A.Hopkins
*	Dampier-Burrup Archipel. Survey	K.Morris
*	Management Plans: N.W. Islands	K.Morris
*	Interactions of Fire and Site on Vegetation in the Walpole-Nornalup National Park	G.Wardell-Johnson
*	Bird communities of the Walpole-Nornalup National Park	G.Wardell-Johnson

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 Uraba lugens.	I. Abbott
32/85	External symptoms of infestation of Karri by the borer Tryphocaria acanthocera.	I. Abbott
24/86	The impact of repeated defoliations on the wood growth of Jarrah saplings.	I. Abbott
39/86	Avian predators of the caterpillars of the Gumleaf Skeletonizer.	I. Abbott
57/86	Diameter growth of Jarrah poles resistant and susceptible to Jarrah Leafminer.	I. Abbott
59/86	Survey of the incidence of infestation of the borer Tryphocaria acanthocera in even - aged Karri.	I. Abbott
60/86	Long term impact of folivorous insects (especially the Jarrah Leafminer) on Jarrah wood growth in the southern Jarrah forest.	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

FAUNA CONSERVATION

7/86	Western desert mammal conservation studies	D.J.Pearson
7/86	Search for mainland populations of Shark Bay mouse, Pseudomys praeconis	K.D.Morris
8/86	Patterns of decline in the Western Australian mammal fauna	A.A.Burbidge et al.
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 studies: population & habitat	J.A.Friend
42-43/86	Translocation	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.	D.Algar
130/86	Chiropteran Studies: Mormopterus taxonomy	N.McKenzie
132/86	Mammals of Pilbara Islands	K.D.Morris
133/86	Conservation of Western Australian marine turtles - Pilbara area.	RIT Prince et al.
142-144/86	Dugong conservation - northern Western Australia	R.I.T Prince
142-145/86	Management of Dugong & marine turtle exploitation in northern Western Australia	R.I.T Prince et al.
147-149/86	Conservation of the Chuditch	-
*	Kangaroo management program	R.I.T Prince et al.
*	Ecological studies of three species of tree rats on the Mitchell Plateau, Kimberley, W.A.	G.R.Friend
*	Western desert fauna studies	D.J.Pearson
*	Conservation of the Hooded Plover in Western Australia	A.H.Burbidge

FIRE PROGRAM

19/78	Slash burning guides for Pinus radiata plantations	N. Burrows.
28/78	Forest fire behaviour under dry fuel conditions (Jarrah)	N. Burrows.
30/83	The Mount Soil Dryness Index for use in W.A. fire control.	N. Burrows.
6/84	Does hollow availability limit Mardos in karri.	G.Wardell-Johnson
7/84	Fire and the Tammar Wallaby.	G.Wardell-Johnson
8/84	Fire, season and termite activity.	G.Wardell-Johnson
15/85	Fire damage to regenerated Karri stands	L. Mc Caw
21/85	Prescribed fire behaviour in regenerated Karri stands.	L. McCaw

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
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 Banksia low woodlands.	N. Burrows et al.
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, Eneabba 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 straegies in heathland and shrubland vegetation.	L. McCaw
23/87	The effect of fire on Lambertia rariflora	N. Burrows
42/87	Fire behaviour studies in hummock grasslands.	N. Burrows
46/87	Forest fauna conservation : formation of hollows in karri trees.	G.Wardell-Johnson
13/88	Fire and regeneration of Eucalyptus wandoo	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 an 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

FLORA CONSERVATION

8	Revision and conservation status of Beaufortia and Regelia	A.A. Burbidge
18	Biogeography and taxonomy of creeping triggerplants (Stylidiaceae).	A.H. Burbidge
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 et al.
27	Germ plasm storage program for rare and endangered and rapidly declining flora.	D.J Coates et al.
28	Determination of the hybrid status of some rare flora.	D.J Coates et al.
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 Eremaea (Myrtaceae).	D.J Coates
31	Hybridization and gene exchange in a Stylidium contact zone.	D.J. Coates
32	Establishment of field herbaria in all regional and district offices and ranger stations.	R.E.S Sokolowski et al.
66	Additions and deletions to the declared endangered flora.	S.D Hopper et al.
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 et al.
70	Licensing and management of the wildflower industry.	S.D Hopper et al.
71	Reservation status of commercially exploited taxa.	S.D Hopper
72	Conservation of two kangaroo paw species. M.App.Sci students Curtin University, Supervisors and	S.D Hopper
72	Harvesting techniques used in the wildflower trade.	S.D Hopper
73	Review of rare flora conservation in Western Australia.	S.D Hopper et al.
74	Flora poster, leaflets, magazine articles and public lectures.	S.D Hopper et al.
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	A revision of Caladenia, Drakaea and allied genera of orchidaceae in Western Australia.	S.D Hopper
78	Orchids of metropolitan Perth.	A.P Brown/ S.D Hopper
79	Generic relationships and evolution of Caladenia, Chloraea and allied orchids.	S.D Hopper
80	A revision of Eucalyptus wandoo and allied species (Eucalyptus series Levispermae). M.I.H. Brooker (CSIRO, Forest Research)	S.D Hopper
81	Twenty new Eucalyptus from Western Australia. M.I.H Brooker (CSIRO, Forest Research)	S.D Hopper
81	Taxonomy of new Western Australia Eucalyptus. M.I.H. Brooker (CSIRO, Forest Research).	S.D Hopper
82	Bird pollination, nectar flow and the mating system of Ecualyptus caesia.	S.D Hopper et al.
83	Conservation status, morphometrics and allozyme variation on Eucalyptus marcrocarpa and allied species.	S.D Hopper.
87	A guide to the Eucalypts of the Stirling Range.	S.D Hopper et al.
87	Eucalyptus carnabyi - rare hybrid or relict species?	S.D Hopper

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
88	Eucalypts of the Great Victoria Desert.	S.D Hopper
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.	S.D Hopper et al.
*	Endangered Flora Wildlife Management Plan for Acacia anomala.	S.D Hopper
*	Endangered Flora Wildlife Management Plan for Drakaea jeanensis.	S.D. Hopper
*	Endangered Flora Wildlife Management Plan for Banksia cuneata.	S.D Hopper
*	Endangered Flora Management Plan for Stylidium corniforme.	S.D. Hopper
*	Endangered Flora Management Plan for Northern Forest Region. Consultant botanists	S.D Hopper
*	Reproductive biology and management of Eucalyptus rhodantha. J. Sampson, S.H James (U.W.A.),	S.D Hopper
*	Eucalyptus of Western Australia salt lakes including the new series Rigentes with three new species. M.I.H Brooker (CSIRO, Forest Research),	S.D Hopper
*	Systematics of the genus, Stylidum.	D.J Coates
*	Conservation status and biology of granite rock endemics of the whealtbelt.	S.D Hopper
*	Conservation status and biology of granite 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 Hopper
*	Conservation of the status and biology of granite rock endemics of the south coast.	S.D Hopper
*	Atlas of rare and endangered W.A eucalyptus.	S.D Hopper et al.
*	Wildflower Industry Wildlife Management Plan Anigozanthus pulcherrimus and Macropidia fuliginosa.	S.D Hopper
*	Review the distribution and commercial utilisation of Boronia species and develop a Wildflower Industry Management Plan.	S.D Hopper et al.
*	Carry out an annual review of ANPWS statistics on Western Australia's cut flower trade.	S. D Hopper
*	Orchids Pollination Book.	S.D Hopper et al.
*	Orchids of Kalbarri, Leeuwin- Naturaliste, Walpole-Nornalup, Fitzgerald River and Cape Le Grand National Park.	S.D Hopper et al.
*	Book on rare and endangered W.A. flora.	S.D. Hopper

PLANT DISEASES

34/83	Long term monitoring of impact of P.c. (Lang and Balmoral Blocks).	B.Shearer
39/83	Screening radiata for resistance to dieback: field inoculation.	M. Stukely
40/83	Prediction of impact of P. cinnamomi 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 P.c.	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
55/86	Rate of bark turnover in two eucalypts.	J. Tippett
62/86	Factors affecting the susceptibility of P. radiata to invasion.	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 P.c. lesions in jarrah.	J. Tippett
72/86	Injection of healthy Banksia seminuda with fungicide, (Forestyl-Al).	B. Shearer
73/86	The association of pathogens with mortality of Eucalyptus species.	B. Shearer
74/86	Simulation of water movement in the upslope areas of the Northern Jarrah Forest.	B. Shearer
75/86	The impact of A. luteobubalina in the Wandoo forest.	B. Shearer
76/86	Population dynamics of P. c. in jarrah/banksia.	B. Shearer
77/86	The effect of phosphorus acid on lesion development of P.c.	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 P.c. in Banksia attenuata.	J. Tippett
23/87	Distribution of Phytophthora species north of Perth, their impact.	T. Hill
24/87	Treatment of isolated outbreaks of P.c.	T. Hill
34/87	Validation of the P.c. hazard rating system.	B. Shearer
35/87	Phenology of P.c. hazard rating indicators.	B. Shearer
36/87	Hydrology of P.c. 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

RPP No.	TITLE	PRINCIPAL INVESTIGATOR

REHABILITATION

14/76	Rehabilitation species trial.	JR Bartle
12/78	"	"
31/78	"	"
27/80	E. globulus provenance trial	
4/81	1981 Agroforestry trial - Wellington catchment.	R. Moore
6/81	E. wandoo progeny trial.	R. Mazanec/ T. Butcher
10/81	Agroforestry species trial (Vasse 2).	R. Moore
04/82	E. wandoo provenance/family trial on bauxite pit site at Jarrahdale.	R. Mazanec/ T. Butcher
25/82	E. wandoo provenance/family trial on Wellington catchment (Souths Farm).	R. Mazanec/ T. Butcher
38/82	E. maculala provenance trials.	R. Mazanec
40/82	Geographic variation in E. wandoo.	R. Mazanec/ T. Butcher
43/82	Esperance Agroforestry trial.	R. Moore
9/83	Mulching Trial (Flynn's).	R. Moore
38/83	E resinifera provenance trial.	R. Mazanec
32/84	E globulus family/provenance trial.	R. Mazanec
33/84	E accedens family/provenance trial.	R. Mazanec
34/84	E camaldulensis provenance trial	
5/85	E. wandoo gene pool.	R. Mazanec/ T. Butcher
4/86	E. accedens family/provenance trial.	R. Mazanec
5/86	E. pilularis 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
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 Eucalyptus wandoo 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	E. sideroxylon family/provenance trial.	R. Mazanec
7/87	Mound design for reforestation of saline seeps in the Wellington Catchment.	P. Ritson
8/87	E saligna 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 phytophageous insects on sapling wandoo.	P. Brown
40/87	Seedling containers trial.	P. Ritson
41/87	Fertilizer pellets trial.	P. Ritson
55/87	E. globulus 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	E. microcarpa 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 Eucalyptus camaldulensis.	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

RPP No.	TITLE	PRINCIPAL INVESTIGATOR

SILVICULTURE

Jarrah Forest

49/65	Growth rates of pile-sized jarrah in even-aged forest at various stockings.	G. Stoneman
15/66	Jarrah pole thinning - young poles (chalk).	G. Stoneman
1/77	Forest stand manipulation to increase water production.	G. Stoneman
24/82	Enrichment planting trial.	G. Strelein
20/82	Comparison of the effects of a number of alternative silviculture prescriptions.	G. Stoneman
17/83	Seasonal growth of jarrah.	G. Stoneman
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.	G. Stoneman
37/84	Comparison of round-up and Tordon timber control for killing standing jarrah and marri poles in summer.	G. Stoneman
30/85	Rehabilitation of the dieback degraded Warren Catchment and its effect on water quality and quantity.	G. Stoneman
34/85	The effect of delays between notching and application of roundup herbicide.	G. Stoneman
35/85	Effect of concentration of herbicide and stand density on efficacy of Round-up for killing jarrah stump coppice by foliar spray.	G. Stoneman
36/85	The effect of notch spacing on the success of notching with Round-up herbicide.	G. Stoneman
37/85	Comparison of Round-up and Tordon timber control for killing standing jarrah and marri poles in winter.	G. Stoneman
39/85	The effect of Round-up dose on its ability to kill standing jarrah and marri poles in winter using the notching method.	G. Stoneman
40/85	The effect of coverage of foliar spray of Round-up on its ability to kill coppice.	G. Stoneman
41/85	The effect of fire on the success of notching jarrah and marri with Round-up herbicide.	G. Stoneman
3/86	Response of hydrologically important measures of forest density.	G. Stoneman
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.	G. Stoneman
31/86	Effect of Round-up dose.	G. Stoneman
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)	G. Stoneman

Karri Forest

28	Genetic variability and breeding systems in karri	D. Coates
26/78	Karri provenance trials.	R. Mazanec
15/82	Karri spacing trial	P. Hewett
3/84	The effect of thinning fertilization and coppice control on the growth and form of the crop trees	P. Hewett
25/85	Trien Brook based area thinning trial	P. Hewett
19/86	Karri site classification.	G. Inions

Pine

16/58	P. pinaster growth trial at Gnangara.	T. Butcher
19/62	P. pinaster seed orchards No. 1 Joondalup, No 2 Mullaloo.	T. Butcher
3/65	P pinaster provenance trial at Gnangara	T. Butcher
20/65	Basal area control of thinning in P. pinaster, Bassendean sands.	T. Butcher
21/65	P. pinaster progeny trials widespread throughout SW Australia.	T. Butcher
27/65	P. radiata early thinning for particle board.	R. Moore
7/66	P radiata non-commercial thinning.	R. Moore
12/66	P. radiata first thinning study.	R. Moore
48/66	Establishment of large pilot plots for P. pinaster.	T. Butcher
54/66	Basal area control of thinning in P. pinaster.	T. Butcher
17/67	P. pinaster 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 P. pinaster stands.	T. Butcher
34/68	P. radiata seed orchard at West Manjimup.	T. Butcher
16/69	Pine establishment trial at Mt Cooke.	T. Butcher
21/71	P. radiata international gene pool progeny test (RS4 and RS5).	T. Butcher
22/71	P. radiata progeny trials throughout SW Australia.	T. Butcher
29/71	Productivity of second rotation pine at Gnangara and Grimwade.	T. Butcher
8/72	Fertiliser and thinning for P. pinaster on Bassendean grey sand.	T. Butcher
19/72	P. radiata genetics yield trial.	T. Butcher
20/72	P. pinaster genetics yield trial.	T. Butcher
15/73	Grazing and forestry combination in Blackwood Valley.	R. Moore
23/73	Subsequent fertilisation of P. pinaster on yellow sands.	T. Butcher
10/75	Agroforestry plan for Chapman's Lease.	R. Moore
20/75	Pilot plots of P. radiata at Moore River.	T. Butcher

RPP No.	TITLE	PRINCIPAL INVESTIGATOR
20/76	Early fertilization of P. pinaster on marginal sites.	T. Butcher
21/76	Fertilization of adolescent P. pinaster on yellow sands.	T. Butcher
23/76	Fertilization of adolescent P. pinaster on grey sands.	T. Butcher
2/78	Agroforestry trial at Wonnerup.	R. Moore
20/78	Agroforestry regimes with P. radiata.	R. Moore
29/78	P. radiata provenance trial at Busselton [RX. 6(1979)].	T. Butcher
30/78	P. radiata genetic variation in dieback resistance.	T. Butcher/ M. Stukely
25/79	Provenance trials of P. taeda and P. serotina 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	P. pinaster high pruning trial.	T. Butcher
2/81	Timing of fertiliser for maximum response in P. pinaster.	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 P. radiata.	R. Moore
7/82	Pinus pinaster second rotation studies.	T. Butcher
9/82	Forms of nitrogen nutrition for P. radiata.	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 P. radiata.	R. Moore
3/83	Comparison of form and set lift pruning in P. radiata.	R. Moore
6/83	Effect of P. radiata thinning on wind stability.	R. Moore
7/83	Early thinning of P. radiata on clover in Sunklands.	R. Moore
15/83	Combination of Alnus sp. and P. radiata	J. McGrath
25/83	Adjacent 1R/2R pinaster on good/marginal sands at Yanchep.	T. Butcher
29/83	Cultivation and fertilisation of marginal P. pinaster sites at Pinjar.	T. Butcher
28/83	Effect of initial stocking on future growth of P. radiata crop trees.	R. Moore
30/83	P. radiata non commercial thinning.	R. Moore
39/83	Screening established P. radiata for dieback resistance.	M. Stukely
14/84	Sunkland site trial P. radiata Phase III.	P. Jenkins
1/85	Nitrogen source distribution and effect on P. radiata growth	J. McGrath
8/85	P. radiata response to N and P after thinning on red loams.	J. McGrath
17/85	Phosphorus supply and concentration in P. radiata needles.	J. McGrath
1/86	Form and growth rate of selected cuttings of routine seedlings of P. radiata in agroforestry.	R. Moore
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 P. radiata.	J. McGrath
10/87	Frequency of fertilization in thinned P. radiata.	J. McGrath
11/87	The effect of thinning and fertilization on growth of P. radiata.	J. McGrath
33/87	Initial Fertilizer requirements for P. radiata on the South-Coast.	J. McGrath
18/88	Initial weed control and fertilization of P. radiata on the South Coast.	J. McGrath

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 taconomy.	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 1981-85 RAOU Survey of Waterbird Usage of the Wetland Nature Reserves of south-western Australia. (RAOU).	J. Lane
*		
*	Publication of results of the 1988 joint CALM-RAOU assessment of waterfowl abundance in south-western Australia. (RAOU).	J. Lane
*	Publication of results of the 1986-88 joint CALM-RAOU surveys of remote wetlands of probable international importance. (RAOU).	J. Lane
*	Completion of surveys and publication of results of 1986-88 survey of egret breeding colonies in Western Australia. (RAOU).	J. Lane
*	Completion of surveys and 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

RPP No.	TITLE	PRINCIPAL INVESTIGATOR

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
30/84	Seasoning of W.A. sheoak by tunnel kilning and air drying.	G. Brennan
31/84	Seasoning of W.A. sheoak by dehumidified kilning and air drying.	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 P. radiata grown in agroforestry stands.	G. Siemon
71/86	Assessment of volume and product recovery after sawmilling and stockpiling.	K. White
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 P. radiata power poles.	D. Donnelly
16/88	Adhesives for manufacturing of jarrah furniture blanks.	P. Newby
17/88	Sawmilling - effect of saw gauge, packing method and tensioning method.	K. White
19/88	Regrowth Karri stockpiling trial.	L. Matthews

Appendix III
Directory of Expertise of Permanent Professional and Technical Staff

* *indicates professional staff*

* **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.
* **Bartle, J**	Evapotranspiration of trees, tree cropping systems for farms, water resources - quality and quantity (salinity, nutrification).
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.
* **Brown, P**	Tree establishment.
* **Burbidge, AA**	Mammals, *Beaufortia, Regelia*, 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	Biogeographical survey and identification of arid zone flora, general identifications (plants).
* **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).
* **Gioia, P**	Computing

Glossop, B	Seasoning, computing, statistics, biometrics.
* **Halse, S**	Waterbirds, wetlands, aquatic invertebrates, avian population dynamics, avian pests, Ostracoda, pesticides.
Harvey, J	Fire ecology, rehabilitation, kwongan, wheatbelt (Tutanning, Kellerberrin), southcoast (Two Peoples Bay), Recherche Archipelago.
* **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**	Flora conservation, flora identification (especially orchids and eucalypts), plant systematics and evolution, pollination ecology, wildflower industry, rare and endangered flora.
Jenkins, P	Agroforestry, pine silviculture.
* **Keighery, G**	W.A. Liliaceae, Apiaceae, *Opercularia, Chamelaucuin - 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, pest management, duck hunting.
Leftwich, T	Radio-telemetry, dietary analysis, biological survey techniques, exotic and feral animal control techniques.
Liddelow, G	Fauna, Perup field course.
* **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.
* **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, microbiology.
Munro, D	Waterbirds, wetlands.
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).
* **Pearson, D**	Fire ecology, aboriginal liaison, arid zone vertebrates.
Pearson, G	Waterbirds, wetlands.

*	**Perry, G**	Plant taxonomy: naturalized flora, Loganiaceae, Plant names.
*	**Prince, R**	Kangaroo management, dugongs, marine turtles, Shark Bay area, wildlife management.
	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.
*	**Stoneman, G**	Jarrah, Karri, forest, hydrology, tree growth, wood production, water relations, silviculture.
	Stritoff, J	Tree breeding.
*	**Stukely, M**	Plant diseases.
	Tay, F	Mycology, wood quality, general pathology.
	Thomson, A	Sawmilling, seasoning, wood properties.
	Van Heurck, P	Insect identification.
	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.*
	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.

Appendix IV
Representation of Research Staff on Committees

Research Scientists

Internal	External Representing Department	External Non-Departmental
IAN ABBOTT 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
JOHN BARTLE Research Division Policy Group (as required); Rehabilitation Program Northern Forest Region, Regional Leaders' Group	Integrated Catchment Management Policy Group Steering Committee for research on Land Use and Water Supply Forest Management Subcommittee Bauxite Subcommittee Water Resource Catchment rehabilitation Coastal Plain Land Management Subcommittee Aquatic Ecosystems Subcommittee Peel Inlet Management Authority Peel-Harvey Implementation Steering Group	
GARY BRENNAN	Timber Seasoning Working Group Wood Properties Research Working Group Australian Timber Research Institute Seasoning Committee	
PAUL BROWN CALM Rural Advisers Committee	Research Co-ordination Executive Committee for Land Salination The Prosopis Introduction Committee	
ALLAN BURBIDGE Aerial Photography Committee; Endangered Fauna Working Group	RAOU WA Group Research Committee	
ANDREW BURBIDGE 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
NEIL BURROWS Perup Ecology Centre; Regional Leaders Group, Southern Forest Region; Fire Management on Nature Conservation Lands. National Workshop Co-convener	AFC - RWG6 - Fire Management	
TREVOR BUTCHER	AFC - RWG Forest Genetics Technical Committee - Gnangara Mound Recharge Southern Tree Breeding Association Eucalyptus Globulus Breeding Association	
MIKE CHOO Research Division Computer Users Group	LISSC - Vax Users Group WALIS - Restricted Site Databases	
PER CHRISTENSEN Research Division Policy Group	Research Steering Committee (Aquatic ecosystems research Subcommittee) Australian Forestry Council Directors of Research Committee WURC Management Committee	

Internal	External Representing Department	External Non-Departmental
DAVID COATES Wildflower Industry Review Committee.		Floriculture Industry Advisory Committee
GORDON FRIEND Roadside Vegetation Conservation Workshop Committee W.A. Fire Management Workshop CALM/CSIRO Research Co-ordinating Committee		
TONY FRIEND Dryandra State Forest Planning Team	Numbat Breeding Management Advisory Committee	
STUART HALSE Herdsman Lake Management Plan Team	Herdsman Lake Argentine Ant Adv Committee Gnangara Mound Wetlands Technical Subcommittee	
PENNI HEWETT	AFC - RWG12 - Native Forest Silviculture	
ANGAS HOPKINS 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)
STEVE HOPPER 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 CONCOM WG on Endangered Flora 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
GREG KEIGHERY Landscope Committee		
KEVIN KENNEALLY Kimberley Flora Committee Herbarium Garden Committee (Chairman)	W.A. Government Biological Surveys Committee Herdsman Lake Management Committee Kimberley Research Project	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
BEVERLEY KOCH Kimberley Flora Committee Kingia Editorial Board		
NICHOLAS LANDER Nuytsia Editorial Board (Editor) Herbarium Computer Committee		
JIM LANE	Midge Research Steering Committee (Chair) CONCOM WG on International Agreements Relating to Migratory and Wetland Birds Yenyenning Lakes Working Group (Chair) Associated Minerals Consolidated Wetlands Management Committee	RAOU Research Committee
TERRY MACFARLANE Herbarium Computer Committee Convener Reference Herbarium Committee Nuytsia Editorial Board Scientific Publications and Editorial Committee		Australian Systematic Botany, CSIRO Editorial Committee
NEVILLE MARCHANT Nuytsia Editorial Board		Murdoch University Grounds Committee

Internal	External Representing Department	External Non-Departmental
BRUCE MASLIN Research Division Policy Group (Acting) Herbarium Computer Committee		International Group for the study of Mimosoideae - Australian Co-ordinator
JOHN MCGRATH	AFC - RWG3 - Forests Soils and Nutrition AFC - RWG5 - Plantation Silviculture	
LACHLAN MCCAW Regional Leaders Group - Southern Forest Region Protection Branch Meetings Fire Management on Nature Conservation Lands National Workshop Co-convener	AFC - RWG6 - Fire Management (Secretary)	
NORM MCKENZIE Pastoral Areas Conservation Steering Committee	Biological Surveys Committee	
RICHARD MOORE Central Forest Region, Regional Leaders' Group	Water Resource Catchment Rehabilitation Subcommittee WA Agroforestry Working Group National Corresponding Working Group on Agroforestry	International Tree Crops Institute (Committee Member)
KEITH MORRIS	Pilbara Regional Herbarium Committee Burrup Peninsula Working Group NW Island Management Committee	
SUSAN PATRICK Kingia Editorial Board		
GILLIAN PERRY Kingia Editorial Board	Biological Control Committee (Department of Agriculture)	Special Committee on lectotypification
BOB PRINCE Kangaroo Management Review Group of Fauna Committee, NPNCA Dampierland Aboriginal Training Program - Project Work Working Group, Wildlife Conservation Act Revision	IUCN Species Survival Commission, Sirenia Specialist Group	
BARBARA RYE Kimberley Flora Committee		
BRYAN SHEARER Dieback Photography Committee	Dieback Hydrology Research Group Department of Agriculture - P. cinnamomi Working Party AFC -RWG7 - Forest Pathology	
GRAEME SIEMON Wood Utilization Research Centre Management Committee	WA Regional Committee, Australian Timber Research Institute WA Australian Softwood Production Association Standards Association of Australia WA Pesticides Advisory Committee - Reviewer	
TONY START 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	
GEOFF STONEMAN Scientific Publications Editorial Committee	AFC - RWG9 - Forest Hydrology AFC - RWG4 - Native Forest Silviculture RSC - Research Catchments Group RSC - Forest Management Subcommittee	W.A. Hydrology and Water Resources Panel
DAVID WARD Corporate Data Steering Committee Research Division, Computer Users Group		
GRANT WARDELL-JOHNSON Task force into the mapping of defined community types in Karri regeneration	AFC - RWG12 - Forest Fauna Walpole-Nornalup National Park Management Plan Committee	

Internal	External Representing Department	.External Non-Departmental
JUDITH WHEELER Kimberley Flora Committee		
MATTHEW WILLIAMS Research Division, Computer Users Group		
PAUL WILSON		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
TONY ANNELS		Manjimup Natural History Club
ANDREW BROWN Wildflower Industry Review Committee	WA Native Orchid Study and Conservation Group Endangered Orchid Species Working Group	
RAY CRANFIELD Herbarium Garden Committee	Department of Agriculture Laboratory Safety Committee	
RICHARD FAIRMAN Safety Committee		
PHIL FULLER Chemicals Committee		
BRETT GLOSSOP Computer Users Group	Timber Seasoning Working Group	
JUDITH HARVEY	Star Swamp Management Committee	
GRANT PEARSON	Mosquito Control Review Committee	
BETH READ Research Division, Computer Users Group		
RON SOKOLOWSKI Wildflower Industry Review Committee		
ALAN THOMSON	Timber Seasoning Working Group	
PETE WALSH Research Division, Computer Users Group	Husky Hunters Users Group	
KIM WHITFORD Research Division, Computer Users Group		
ANDY WILLIAMS Firearms Policy Committee		
YVONNE WOODS 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	
*Bartle, J	30	20	20	30
Bellgard, S	98	2		
Birmingham, T	95	4	1	
Bopp, J	100			
*Brennan, G	85	7.5	7.5	
Bromilow, B	100			
Brown, A	60	30	10	
*Brown, P	60	20	20	
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	15	5	
Calvert, G	100			
*Chapman, A (0.4 FTE)	100			
*Choo, M	90	10		
*Christensen, P	20	15	25	40
*Coates, D	60	15	15	10
Crane, C	90	10		
Cranfield, R		40	50	10
*Crombie, S	100			
Cully, M	100			

	Research Activities	Extension within CALM	Extension outside CALM	Administration
*Davison, E	75	25		
Dillon, M	94	5	1	
Dumbrell, I	100			
Fairman, R	98	2		
Farr, J	80	10	10	
Freeman, I	98	2		
*Friend, G	80	15	5	
*Friend, J	80	10	10	
Fuller, P	90	5	5	
Giles, R	68	2		30
*Gioia, P	90	10		
Glossop, B	85	7.5	7.5	
*Halse, S	50	30	20	
Harvey, J	80	10	10	
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	25	15	
*Kenneally, K	70	15	15	
Kennett-Smith, A	98	2		
Kinal, J	98	2		
*Kinnear, J	80	10	10	
*Koch, B (0.5 FTE)	90	5	5	
*Lander, N	85	5	10	
*Lane, J	50	10	10	30
Leftwich, T	100			
Liddelow, G	70	15	15	
*Macfarlane, T	60	10	30	
Maisey, K	90	10		
*Marchant, N	75	10	15	
*Maslin, B	80	10	10	
Mason, M	95	5		
*Mazanec, R	95	5		
McArthur, S	100			
*McCaw, L	70	5	5	20
McDonald, D	100			
*McGrath, J	50	10		40
*McKenzie, N	70	10	10	10
Mitchell, D	90	10		
*Moore, R	50	10	30	10
*Morris, K	80	10	10	
Munro, D	80	5	5	10
Neal, J	90	10		

	Research Activities	Extension within CALM	Extension outside CALM	Administration
Onus, M	95	5		
Parker, C (0.5 FTE)	100			
*Patrick, S	15	35	50	
*Pearson, D	85	10	5	
Pearson, G	65	10	5	20
*Perry, G	80	5	15	
Portlock, C	94	2	4	
*Prince, R	60	10	10	20
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	100			
Searle, J (0.5 FTE)	100			
*Shearer, B	68	10	2	20
*Siemon, G	70	10	10	10
Skinner, P	90		10	
Smith, R	100			
Sokolowski, R	85	5		10
Spencer, P	100			
*Start, T	35	15	10	40
*Stoneman, G	90	8	2	
Stritoff, J	90			10
*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	
Vellios, C	100			
Walsh, P	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	80	10	10	
Wong, L	100			
Woods, Y	100			

Appendix VI
Benefits Of Research - Some Case Studies

Each revision of the Five Year 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.

DECLARED RARE FLORA

The flora of Western Australia is world renowned for its richness (about 10 000 species of flowering plants, 2 000 yet to be named) and high endemism (75-80% of the species in the south-west are found nowhere else). Plant geographical studies have established that areas exceptionally rich in species in the State coincide with the cereal growing wheatbelt and other heavily cleared regions, notably in the Stirling Range, Fitzgerald River National Park, Mt Lesueur-Eneabba region, Kalbarri area, Darling Scarp and the western edge of the wheatbelt between Bindoon and Cranbrook.

These areas have the greatest concentration of rare and threatened plants known in Australia. Some 2 000 species have been listed by various authorities as needing research on their conservation status. Such work is essential if the objective of the World, Australian and Western Australian Conservation Strategies of "preserving genetic diversity" is to be met.

An additional impetus for such research is provided by the unique legislation protecting declared rare flora in the State. This includes provisions affecting all citizens on all lands, with substantial fines possible for convicted offenders.

Faced with such a long list of species needing attention, the small flora conservation research team in CALM has achieved a remarkable level of protection of the State's rarest and most endangered plants. This has occurred through the researchers seeking the cooperation of many interested groups in locating populations, and then ensuring the development of an efficient administrative system for notifying landowners and liaising with them by CALM staff. Accidental bulldozing of rare plant populations has decreased to almost zero as a consequence. In addition, many authorities and landowners have become enthused about conserving their rare and endangered plants, and undertaken positive management at their own expense.

A strong focus on communicating scientific information (taxonomy, biogeography, ecology) to CALM operations staff and to the landowners they deal with has achieved effective conservation of a greater proportion of the State's plants most at risk than more academic approaches had achieved in the past.

BIOLOGICAL SURVEY OF THE KIMBERLEY

As late as 1970 most of the Kimberley was *terra incognita* as far as its plants and animals were concerned. What little was known mainly dated from early explorers or was restricted to a few areas where road access was possible. Certainly, no one was in a position to make any clear, scientifically-based statements about the conservation status of the plants and animals, ecosystems or landscape of the area, nor about the best places for reserves for national parks or nature reserves.

When the Conservation Through Reserves Committee was set up by the EPA in 1972 they quickly decided that they were in no position to make recommendations about reserves in the Kimberley and deferred their report on the area.

Systematic, modern biological surveys in the Kimberley began in 1971 when the Department of Fisheries and Fauna documented the wildlife of the continental islands. Access in 1971 was provided by the Australian Army, who were in the areas making maps and had helicopters. The work continued in patrol and research vessels. As well as Departmental scientific staff, the study teams included botanists from the W.A. Herbarium and zoologists from the W.A. Museum.

By 1973 the islands were becoming comparatively well known and the emphasis switched to the mainland with helicopter-assisted surveys of the only two significant conservation reserves in the Kimberley - the Prince Regent Nature Reserve in 1974 and the Drysdale River National Park in 1975. This work had a cascading effect because both the Herbarium and Museum started their own studies in the Kimberley and several other organizations also became interested in the region.

By 1977 the CTRC was ready to release its report on the Kimberley. However, work did not stop there, because biologists who knew the region well understood how uneven and incomplete their knowledge was. The Bungle Bungle area, for example, was completely unstudied and most people had never heard of it. Studies became more specific, with work including studies on crocodiles, mangroves and rainforests. These surveys resulted in many new species of animals and plants being discovered and we now have a reasonable overview of the region's biota.

In 1987, with the Kimberley Region Planning Study underway, CALM was in a position to provide a comprehensive overview of the region and descriptions and recommendations for many parcels of land throughout the region. Without the biological surveys this would not have been possible. The improved biological knowledge of the area has had other benefits, e.g. it has allowed better evaluation of ERMPs such as that for the Argyle Diamond Mine.

Biological surveys in the Kimberley have been difficult and time-consuming. The great distance from Perth coupled with the problems of access to many areas have combined to keep costs high. However, if the work had not been done we would not know where to start with nature conservation in the Kimberley today.

FOREST FIRE RESEARCH

The major eucalypt and pine forests occupy only 2 million hectares and are restricted to the south-west corner of W.A. These forests are managed for a wide range of protective and productive values and some 0.5 million people live near or within the forest region. Each year this region experiences hot dry summers during which wildfire regularly starts in the forest.

For example, in the 30 year period 1954-84, foresters dealt with 8 533 fires burning in or threatening State Forests. This represents an average of 284 fires each year. Many of these fires occur during extreme weather conditions and can have catastrophic consequences: lives are lost, property is destroyed, and they may cause serious resource losses.

The suppression of high intensity forest fire is highly dangerous and very costly. Nineteen firefighters lost their lives fighting forest fires in South Australia and Victoria in 1983. The direct fire fighting costs of suppressing one wild fire in karri forest in 1969 exceeded $100 000, equivalent to approximately half to a million of today's dollars.

Foresters of W.A. have been concerned about the problem of wildfires since the beginnings of forest management in the 1920s. The current approach of CALM is based on the premise that because fires are inevitable, the aim is to minimize its undesirable consequences. This involves maintenance of an efficient fire detection system backed by effective fire fighting forces, together with systematic reduction of flammable fuels on the forest floor by rotational prescribed burning.

Current estimates show that the organization required to suppress a large forest fire can cost up to $40 000 per day. Such a fire may take 5 or more days to contain. Experience also shows that direct attack on forest headfires is not likely to succeed when flame heights are more than 3 m or are moving faster than 100 m/hr. Fire behaviour is directly affected by the amount of fuel; if fuels on the forest floor are kept at reasonably low levels there is a good chance of control by suppression forces. This applies even under severe weather conditions.

There have been no major fires since 1961 in the jarrah forest where a fuel reduction burning program commenced in 1954 or since 1969 in the karri forest where the fuel reduction policy became effective in the late 1960s. During this period no single firefighter has been burnt to death in a forest fire in W.A. nor has there been any losses of life of civilians living in or near the forest zone.

This contrasts with the "Ash Wednesday" fires in Victoria and South Australia in February 1983 which resulted in 70 deaths and hundreds of serious injuries.

The effectiveness of CALM's fire suppression strategy depends to a very large degree on the fuel reduction program. A comparison of W.A. with the other states illustrates this point. The most severe fire behaviour can occur in dry sclerophyll forest types. W.A. has the largest proportion of this forest type (87%) in comparison with the other states (Victoria 76%, Tasmania 67%, NSW 24% and Queensland 12%).

In spite of this the average size of wildfires in this State is less than in any other State, as indicated by the following table.

Wildfire Data 1984/85
(Data for 1982/83 in parentheses)

Forestry Authority (State)	No. of Wildfires	Area Burnt	Average Fire Size
Tasmania	71 (255)	2 230 (62 385)	31 (245)
Western Australia	267 (247)	16 951 (11 513)	63* (47)
Queensland	81 (270)	19 000 (197 000)	234 (730)
Victoria	522 (823)	240 037 (486 030)	460 (590)
New South Wales	464 (499)	1 596 002 (312 428)	3 439 (626)

*one fire 10 400 ha, remainder averaged 25ha

This largely attributed to the program of regular fuel reduction burning in the forest areas of this State. The area which is fuel reduced annually is far higher in W.A. than in any other State (see following table).

Fuel Hazard Reduction Burning 1984/85 - Forestry Lands

State	Area burnt (ha)	% of Total Area Protected
Tasmania	38 100	2.4
Western Australia	272 112	13.3
Queensland	10 423	2.4
Victoria	*106 400	2.3

*Includes National Parks - separate data not available

The W.A. fire protection program was also relatively cost effective, as indicated in the tabulation below.

Annual Cost of Prescribed Burning Program in Each State

State	$ Per Hectare	$ Per Capita
Tasmania	1.3774	5.7695
Western Australia	0.9744	2.2896
Queensland	0.3484	0.6719
Victoria	1.4084*	3.1734
New South Wales	1.4827	1.0704

*Based on Victoria's total area of responsibility of some 8.65 million hectares which appears to include all Crown land. Only minimal protection may be required for a significant part of Victoria's area of responsibility, given that the total area of public forests including National Parks is some 4.3 million hectares.

The fuel reduction program which is such a vital part of CALM's fire strategy is based on results of very detailed research carried out over a period of over 20 years by the Research Branch of the former Forests Department, which is now a part of CALM's Research Division. Detailed monitoring and analysis of many hundreds of small trial burns have resulted in a level of understanding of fire behaviour which is necessary to carry out prescribed burning safely and economically. The complex interactions between fuel factors such as amount of fuel, distribution, composition, moisture content etc. and climatic factors such as wind and relative humidity, could not have been worked out without extensive and detailed research.

The field work component of this research is very high and it can only be done effectively by research based at Regional or District Centres. In addition there is a need for researchers to be fully familiar with forestry operations and to be in a position to liaise with District and Regional staff to ensure that the results of this work is properly put into practice. Thus almost all of this work has been done by researchers based at Dwellingup and Manjimup.

In recent years fire behaviour research has expanded to encompass fire effects. The results of fire effects research in the Perup area for example, has resulted in a detailed fire management plan which will ensure the continued survival of the rare and endangered Woylie *(Bettongia penicillata)* and the Tammar Wallaby *(Macropus eugenii)*.

More recent research in the increasing area of young Karri regrowth has produced data on fire behaviour which will enable these stands to be fuel reduced at an early age ensuring the protection of this very valuable resource from wildfire.

The fire research expertise which has been built up over many years in the Department is now being applied to solve fire management problems in National Parks and reserves in other parts of this State.

TREES FOR SALINITY CONTROL

The rationale of tree planting to control salinity is to reverse the process of groundwater accumulation and salt mobilization caused by reduced evapotranspiration under agriculture.

In seeking suitable tree species to achieve this it was considered unwise to rely solely on native species because of the alteration to the natural environment which accompanies agriculture, especially the possible spread of the dieback fungus. On the other hand it was considered to be quite a tall order to find an introduced species which could efficiently exploit the difficult deep soil environment and duplicate the exceptional evapotranspiration capacity of the native species. A corollary of the 'difficult environment' assumption was pessimism about the commercial potential of trees. It was considered likely that the best adapted trees for deep rootedness and evapotranspiration would also be slow growing (up to 100 years rotation length) and therefore totally uncompetitive in relation to agriculture which produces an annual income. Against this background of thinking a major species selection project was commenced in 1978. Some 80 prospective species were planted in large plots at 5 locations to serve as a base for the evaluation of growth and evapotranspiration performance. The species used in this project included slow growing, drought, salt, fire and dieback tolerant species as well as some with better production potential.

Evaluation of performance in these plantings commenced in 1985. This work identified several species which conformed with the slow growing, non-commercial, copious transpiration prediction. These species were rapidly included into farm tree planting through CALM nurseries and included in the Wellington Catchment reforestation planting. However some potentially commercial species also had reasonable transpiration capacity. This finding was supported by related studies on groundwater drawdown under tree plantations where commercial species also showed up impressively.

This work established the technical basis for treatment of the salinity problem. Commercial species could be used to achieve major gains in reduction of groundwater, with the specialized non-commercial species relegated to mopping up the remaining groundwater on the difficult sites such as salt seepage areas. This greatly increases the potential for economic treatment of salinity and opens the hope that regional scale treatment of degraded land, wetlands, riverine ecosystems, and water resources can be addressed.

Three of the commercial species (ie *Eucalyptus globulus, E. viminalis* and *E. botryoides*) can be used for production of chip for pulp. An interim

sharefarming scheme has been devised to operate in 1988 to undertake broadscale planting so *E. globulus* to initiate what is hoped will become a major new industry.