Science and Information Division

Triennial Report 1992/95

For the period July 1992 to June 1995

Department of Conservation and Land Management

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Contents

The next triennium

This publication documents the research carried out by the science staff of CALM's Science and Information Division over the past three years.

In an operationally-based agency such as CALM, our Science Program focuses on the applied research needs of the Department and it is the Science Division's role to provide CALM with the scientifically-sound information it requires to conserve and manage Western Australia's biotic resources.

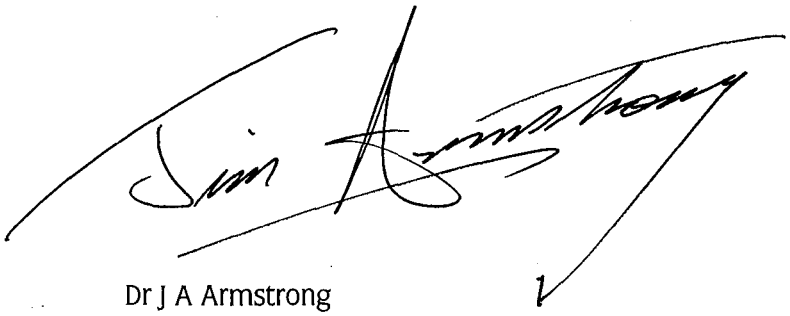
The past triennium has been a difficult time for the Division, faced as it was with major structural changes and a significant downsizing of its budget and its staff resources. Despite such difficulties, the productivity of the science staff has increased and the Division has achieved an enviable record of achievements. Some of the highlights include:

- Success in the federal governments Co-operative Research Centres program. CALM is a partner in the CRC for Biological Control of Vertebrate Pest Populations and in the CRC for the Sustainable Development of Tropical Savannas.
- Externally funded research projects exceeded $7.5 million in the past three years.
- Production of over 400 scientific publications, mostly in externally refereed national and international journals.
- The establishment of our new science journal CALMScience. This new journal was first published in December 1993 and has been produced to date as five issues in two volumes, together with four CALMScience Supplements. CALMScience, together with our other well established science journal Nuytsia, documents the impressive scientific work of CALM's science staff.
- A significant increase in collaborative research programs with kindred agencies.
- A greater involvement in supervising the research projects of university students and assisting university departments in designing and implementing their research programs.
- An increased international profile through active involvement in various United Nations programs such as the Convention on International Trade in Endangered Species (CITES), Botany 2000 and UNESCO; various IUCN's Species Survival Commission Specialists Groups; and with the International Foundation for Science.
- Production of the Division's Strategic Plan in 1995. This important science planning document will be reviewed again in 1999.
- A computerized, interactive database of SID's Science Project Plans has been devised, making available the full and true cost of each project.
- The concept of Sustainable Conservation, based on the idea that natural communities are best conserved by enlightened utilization of natural resources, has been actively promoted within CALM and to scientists outside CALM.

- A Research Consortium to progress research and development of the anti-HIV chemical conocurvone (derived from endemic Proteaceae) was established. Plans are in train to establish a Drug Discovery Centre in Western Australia. Ultimately this will result in rapid progress in discriminating, documenting, and naming the indigenous biota of the State.

It is pleasing to note that CALM's science staff continued to provide most of the science-based information presented in CALM's wildlife magazine *LANDSCOPE* and that the expertise of our staff is always sought when Regional and District management plans are being prepared or reviewed by the Department.

Clearly, the achievements of the science staff detailed in this report set a firm foundation for the Department's science program in the next triennium. The Science and Information Division looks forward to a future of great promise and sustained productivity.



Dr J A Armstrong
DIRECTOR

The Division

CALM's Science and Information Division (SID) is one of seven Divisions in the Department. Our Mission is to provide up-to-date and scientifically-sound information to underpin and facilitate effective conservation and land management in Western Australia.

CALM's mission is to conserve and manage Western Australia's wildlife and the lands, waters and resources entrusted to the Department for the benefit of present and future generations. CALM has the following major objectives:

- *Conservation:* To conserve indigenous plants, animals and ecological processes in natural habitats throughout the State.
- *Value and Use of Resources:* To optimise the value and economic return to the community of wildlife, lands, waters and resources entrusted to the Department without compromising conservation and other management objectives.
- *Tourism and Recreation:* To identify, provide and maintain opportunities and services to the community which allow them to enjoy the wildlife, lands, waters and resources entrusted to the Department without compromising conservation and other management objectives.
- *Knowledge:* To seek and provide an up-to-date and sound scientific and information basis for the Department's conservation and land management activities.
- *Community Support:* To promote community awareness and appreciation of the values of the wildlife, lands, waters and resources entrusted to the Department, and to develop community understanding and support for the Department's conservation and land management activities.

VISION

Apart from commercially valuable taxa (eg. jarrah, karri and sandalwood) and charismatic taxa (eg. birds, mammals, butterflies and flowering plants), the native biota of Western Australia remains poorly known. Science and Information Division's vision is to develop the operational framework to enable biota to be utilized sustainably. This will generate wealth for the Western Australian community and provide much of the finance to enable land to be managed more effectively and ensure that the State's biodiversity is conserved. The economic value conferred by this program on the remaining native vegetation will also act as a powerful incentive for the cessation of land clearing in Western Australia.

Commercial returns from sustainably utilized natural products will provide the substantial funding needed to conserve and manage the biodiversity of the State. Science and Information Division envisages a small proportion of these funds being used to improve science infrastructure so that the biota of Western Australia is fully discriminated and documented, threatening processes are overcome or mitigated, and the natural resources are used in an ecologically sustainable manner with the least possible disturbance to the environment.

LOCATION

The Division's activities are spread throughout seven Research Centres in Western Australia, with staff in metropolitan Perth, Dwellingup, Manjimup, Busselton, Harvey and Karratha. The human resources provided by the Department to SID number currently some 135 staff, including 47 scientists.

RESEARCH CENTRES (Listed from north to south):

WOODVALE	Manager	Grant Pearson
KENSINGTON	Manager	Chang Sha Fang
COMO	Manager	Francis Tay
DWELLINGUP	Manager	Stuart Crombie
HARVEY	Manager	Gary Brennan
BUSSELTON	Manager	Richard Moore
MANJIMUP	Manager	Lachlan McCaw

The major Research Centres (Woodvale, Kensington, Como, Manjimup) are linked electronically through a wide-area network. Research Centres provide the laboratory and office requirements of scientists in SID. Other SID staff are located at CALM's State Headquarters at Crawley and at Regional offices in Karratha.

Co-located at the Research Centre at Kensington is the WA Herbarium, the principal State botanical collection. Regional herbaria are located in Karratha, Kalgoorlie, Manjimup and Albany.

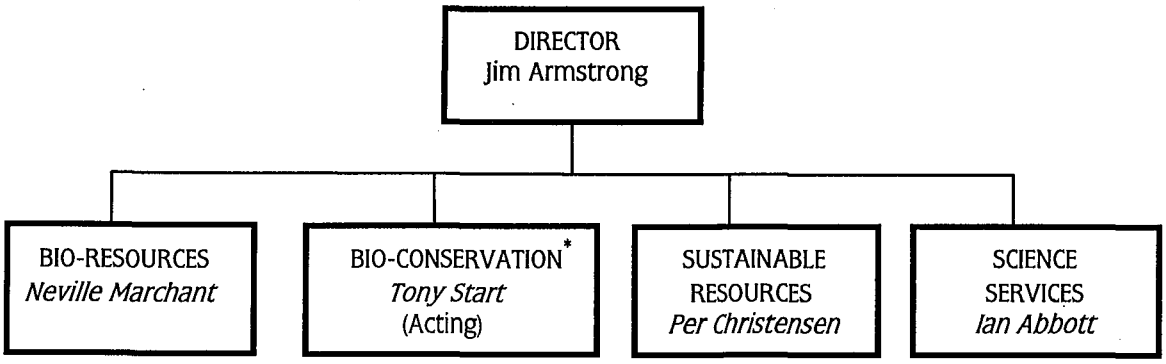
STRUCTURE

Science and Information Division was formed in June 1992 following the appointment of Dr Jim Armstrong as Director. The former Research Division was reviewed, refocused and re-structured during 1992/93. The important outcomes of this process were:

- Explicit change of emphasis from activity (research) to outcomes (science-based knowledge and information).
- Mobilization of the Divisional budget, altering historical allocation of monies to particular staff and projects by re-prioritizing all science projects.
- Restructuring into four functional Groups (instead of the previous three) and amalgamating the existing 13 research programs into seven sections, led by Section Managers.
- Formation of Management Teams, comprising the Group Head and relevant Section Manager, to prioritize science programs and manage financial resources and allocate staff resources to the high priority tasks.
- Introduction of a centralized concept of financial cost centres, focused on the four SID Groups.
- A Strategic Plan for the Division was prepared in 1993, endorsed by the Department's Corporate Executive and published in 1995. All science projects are now aligned with this Plan.

The restructuring of the Division aimed to demonstrably improve integration of CALM's diverse science programs. The Science and Information Division now comprises four functional Groups (see following chart). Three of these groups - Bio-Resources, Bio-Conservation, and Sustainable Resources - are actively science-based. The fourth - Science Services - mostly delivers corporate services. Each Group is led by a Head, who in turn is responsible to the Director of the Division. The Director and the four Group Heads comprise the senior management team of the Division, termed the Science and Information Management Council (SIMC) which determines policy in the Division. Each Science Group consists of two Sections, each administered by a Section Manager. Each Section Manager is responsible for the integration of priorities within the Science Section, the effectiveness of the research done, and fostering interaction within the Section and with other relevant staff. Group Heads are responsible for ensuring that relevant scientific expertise in the Group is integrated and co-ordinated both within the Group and throughout the Division, eg. by the formation of project teams.

SENIOR MANAGEMENT TEAM



SCIENCE PROGRAMS

BIO-RESOURCES

Community Resources

Section Manager: Dr Allan Burbidge

Species Resources

Acting Section Manager: Judy Wheeler

BIO-CONSERVATION

Community Conservation

Section Manager: Dr Gordon Friend

Species Conservation

Section Manager: Keith Morris

SUSTAINABLE RESOURCES

Natural Products

Section Manager: Dr Neil Burrows

Tree Crops

Section Manager: Dr John McGrath

SCIENCE SERVICES

Information Science

Section Manager: Nicholas Lander

* Dr Neil Burrows was appointed Head of the Bio-conservation Group in August 1995.

BIO-RESOURCES

Western Australia is an area recognized on a world scale for its biotic diversity. Available information on species numbers and habitat diversity indicates that Western Australia has a mega-rich flora and fauna with a wide array of habitats. Conservation issues such as feral predators, introduced fungal pathogens, widescale impacts of agriculture, development and the pastoral industry, and management and sustainable utilization of indigenous species require reliable and easily retrieved scientific data.

The Bio-resources Group is concerned with the discrimination and inventory of systematic, biological and ecological information on the biota and documentation of the landscape characteristics and ecological communities of the State. The data on biota and habitats is readily accessible and contributes directly to the determination of conservation values, development of land management techniques as well as provide biological data on threatened taxa and taxa with economic value.

The Group is comprised of two Sections: the *Community Resources Section* which is concerned with the documentation of ecological communities across the State and the *Species Resources Section* which provides information on all biota in the State.

BIO-CONSERVATION

The Bio-conservation Group focuses on those bio-resources of the State which are being diminished or degraded, identifies the processes responsible, and develops practical solutions to enable the threatened biotic resources of the State to be managed effectively.

The Group provides the scientifically rigorous information that empowers those parts of CALM charged with operational conservation and land management to achieve their conservation objectives. It also provides the scientifically rigorous information that supports and develops CALM conservation policies. In that sense those parts of CALM which effect conservation through policy and management are the principal clients of the Group.

At a wider community level, the Group is a major centre of practical expertise in species and community conservation. This provides an unequalled opportunity to foster community understanding and support for conservation, persistence of biodiversity and maintenance of our natural heritage.

SUSTAINABLE RESOURCES

CALM is responsible for the management of a wide range of natural resources utilized by the community for both profit and pleasure. CALM must ensure that these natural resources are used in a sustainable manner with the least possible disturbance and effect on the environment. This includes the growing of exotic plantation trees for wood and other products.

The Sustainable Resources Group comprises two sections, Natural Products and Tree Crops. The role of the *Natural Products Section* is to undertake research into the management and utilization of species from which natural products are derived and to provide science-based advice to managers on their sustainable use. Its role also includes exploring the possibilities for developing new products either independently or in collaboration with other organizations.

The work of the *Tree Crops Section* covers the range from plantations (where the sole aim is wood production) through to tree plantings (where the aim is to either rehabilitate a degraded environment or prevent the degradation of an environment, ie landcare benefits). Between these extremes there will be plantings that produce both productive and landcare benefits.

SCIENCE SERVICES

This diverse Group has the role of ensuring that essential financial, computing, biometrical, publishing, germplasm facilities, and vegetation health services are provided to support the Mission of Science and Information Division. Professional staff in Information Science Section bring a high level of computer-based analytical sophistication to scientific issues relevant to CALM.

OUTCOMES

Science and Information Division has developed a sound reputation for the science done by its members. Evidence for this is as follows:

- New knowledge contained in the many scientific papers and reports written and published by scientists employed by SID (see Fig 1).
- Increasing proportion of permanent scientific staff with doctorates (see Fig 2).
- Cumulative number of specimens databased at the WA Herbarium (see Fig 3).
- Delivery of scientifically-sound solutions for recovering several species of native mammals in south-west Australia from the brink of extinction (see Fig 4).
- Control of dieback disease using ultra low dosages of phosphonate in a phosphorus-sensitive flora (see Figs 5 and 6).
- Demonstration of the genetic basis of resistance to infection of *Phytophthora cinnamomi* in jarrah (see Fig 7).
- Practical recommendations to management to facilitate the conservation of many species of threatened flora (see Fig 8).
- Fine tuning of fertilizer prescriptions so as to maximize growth of the State's pine plantations (see Fig 9).
- Development of new initiatives for the bioprospecting of native flora, which have been internationally recognized. This includes the formation of a consortium of scientists from within CALM, the WA Chemistry Centre and WA universities to progress the investigation of naturally occurring compounds in the flora.
- Ability of scientists to attract research funds from external sources.
- Membership of the Co-operative Research Centres for Vertebrate Bio-control (since 1991) and for Sustainable Development of Tropical Savannas (since 1995).

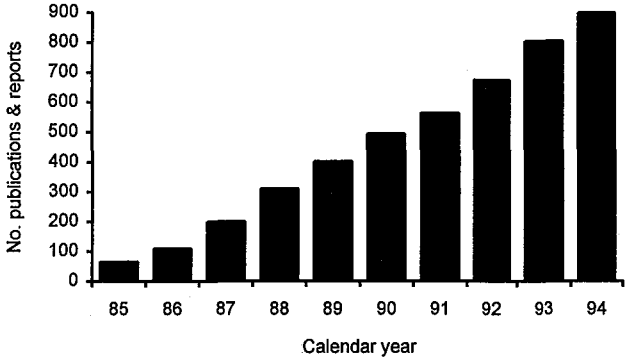


Figure 1
Cumulative number of papers published and major reports written by SID staff

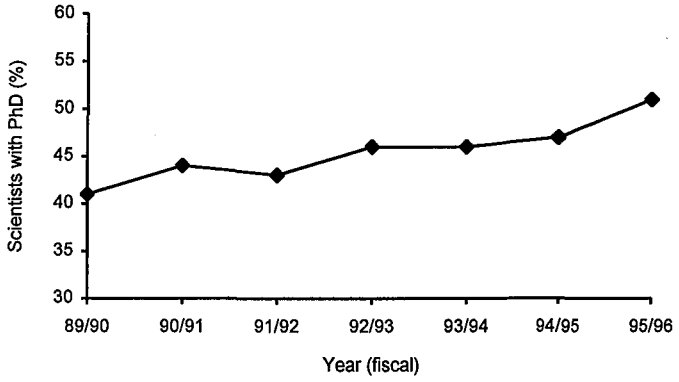


Figure 2
Highest academic qualification held by science staff in Science and Information Division

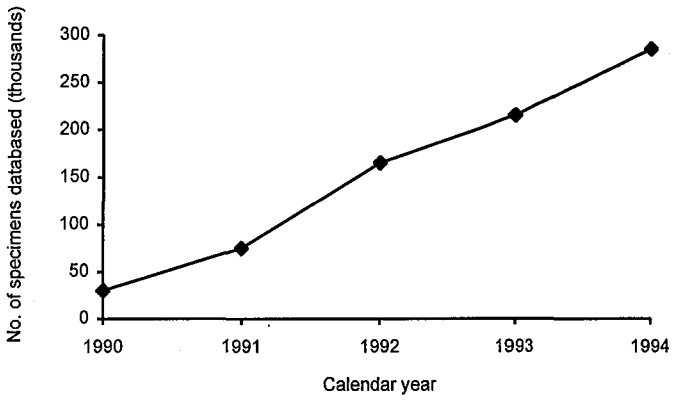


Figure 3
Cumulative number of plant specimens in the WA Herbarium databased over five years
The project was completed by incorporating a further 6859 specimens in the six months to 30 June 1995.

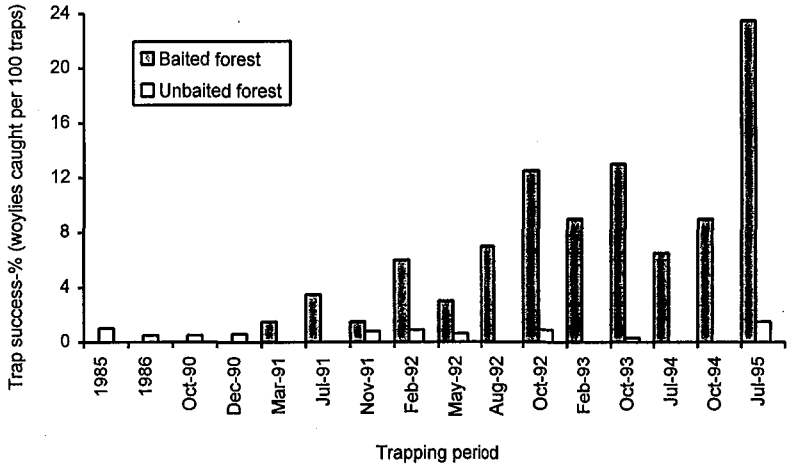


Figure 4
Mean daily trap success rates (%) of woylies in baited and unbaited jarrah forest
(Courtesy Keith Morris)

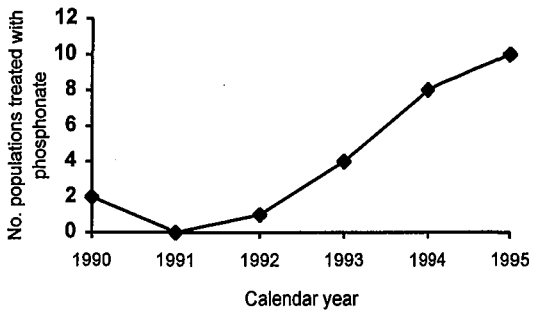


Figure 5
Number of DRF (threatened flora) populations treated with phosphonate since 1990 (financed and co-ordinated by Science and Information Division in collaboration with Albany and Walpole Districts of South Coast Region) (Courtesy David Coates)

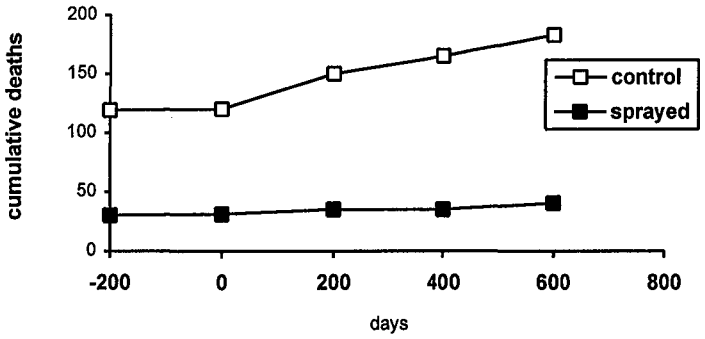


Figure 6
Mortality of *Banksia coccinea* at Gull Rock Nature Reserve following spraying with a 10% solution of phosphonate at a rate of 60 litres/ha (Courtesy Barbara Komorek)

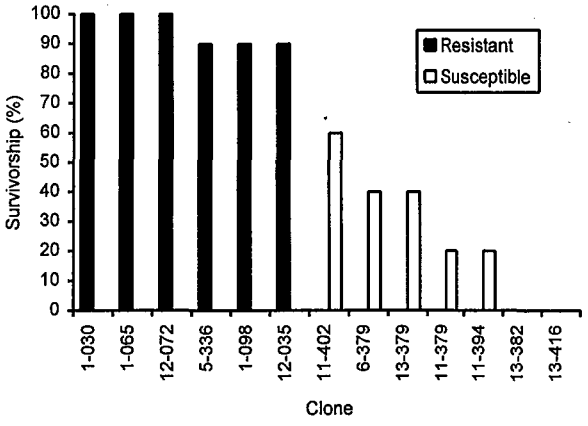


Figure 7
Survivorship of *Eucalyptus marginata* clones, resistant or susceptible to *Phytophthora cinnamomi*, after five years' growth in a *Phytophthora*-infested bauxite mine site (Courtesy Mike Stukely)

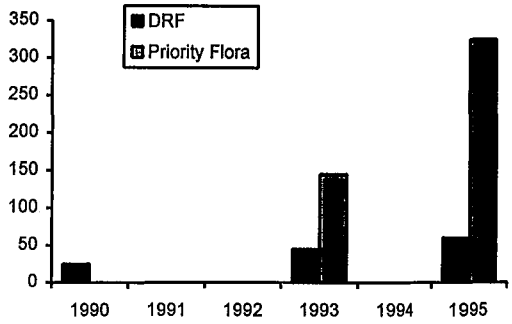


Figure 8
Number of taxa (Declared Rare Flora and Priority Flora) for which specific conservation/management actions have been recommended since 1990. (Data from the four published area-based rare and threatened flora Wildlife Management Programs and three single species Recovery Plans) (Courtesy David Coates)

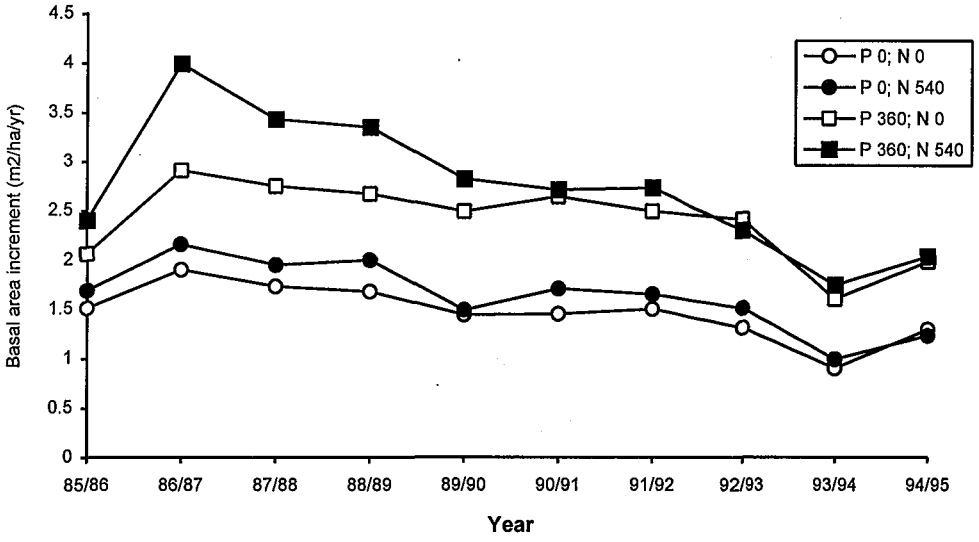
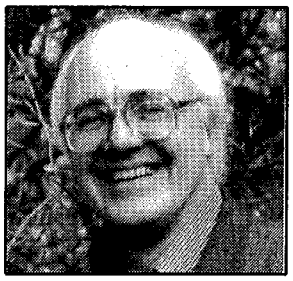


Figure 9
Basal area response of thinned *Pinus radiata* to applications of nitrogen and phosphorus fertilizer (kg/ha) (Courtesy John McGrath)

Achievements of the Division

Science and Information Division is committed to providing up-to-date and scientifically-sound information to facilitate effective conservation and land management in Western Australia.



Dr Jim Armstrong
Director

OBJECTIVES*	ACHIEVEMENTS
To provide a scientifically objective and independent source of reliable knowledge and understanding about conserving species and ecological communities in Western Australia, managing the public lands and waters entrusted to CALM, and carrying out CALM's other legislative responsibilities.	• Prioritized all science projects, resulting in 166 high priority science project plans which are generating new knowledge.
To ensure that Science and Information Division is responsive to the needs of policy makers and managers in CALM by bringing science to bear on the solution of the State's most pressing problems relating to land management and conservation.	• Developed a Strategic Plan for SID and gained endorsement by CALM's Corporate Executive. • Initiated meetings between senior Regional officers and senior SID staff to ensure that SID is addressing high priority issues for CALM's operations. • Developed and prioritized science outcomes relevant to CALM's mission. • Formal interactions between SIMC and CALM's Regions have been initiated (so far with Wheatbelt, South Coast and Swan Regions). These have involved candid communication of the work of SID to Regions and feedback on its appropriateness. • All Science Project Plans were submitted to relevant District or Regional Managers for comment on the relevance of the work to Departmental operations.
To advise CALM on sustainable resource development opportunities and ensure the conservation of biological resources through their sustainable utilization.	• Developed and promoted the concept of sustainable conservation (ie. conservation through sustainable utilization of biotic resources).

* As stated in the Strategic Plan (1995-9) of Science and Information Division

OBJECTIVES	ACHIEVEMENTS
To communicate to managers in CALM the knowledge, information and other insights obtained through scientific investigation in Western Australia and elsewhere.	• Continued to contribute to corporate databases and supplied relevant information to managers in CALM. • Each Science Group held seminars or technical workshops in which research in progress was presented formally to other members of CALM and scientists from CSIRO and Universities.
To attain for CALM a world-wide reputation for excellence in science by publishing knowledge obtained through scientific research in the premier national and international scientific journals.	• Continued to publish in a diversity of national and international science journals, in our own botanical journal *Nuytsia,* and established a new science journal, *CALMScience,* to promote our science more broadly.
To show that the Division, as an integrated part of CALM, contributes to meeting the need for knowledge on conservation and land management matters required by the public of Western Australia.	• Contributed numerous articles to CALM's nationally recognized magazine *LANDSCOPE.*

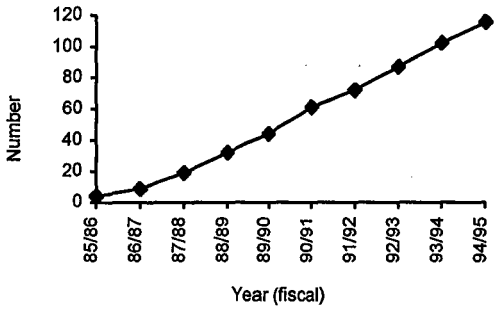
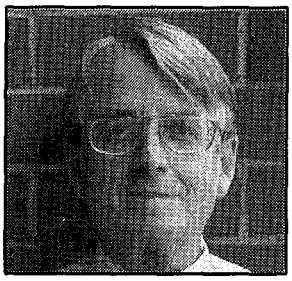


Figure 10
Cumulative number of major articles contributed by SID staff to *LANDSCOPE*

Achievements of the Bio-resources Group

Bio-resources Group is committed to discriminating and describing the biotic resources of Western Australia, and to documenting their location, their abundance and their conservation status.



Dr Neville Marchant
Head of Group

OBJECTIVES	ACHIEVEMENTS
To establish a State resource centre for conservation and economic information on the flora and, in collaboration with other institutes, the fauna of the State.	• Commenced documentation of taxa which have economic significance. • Collaborated with other sections of CALM to ensure currency of information on conservation taxa. • Co-operated with the Western Australian Museum to develop protocols for exchange of information on the inventory of the State's biota. • Completing databasing the accessions of the Bio-resources Library.
To develop and co-ordinate the inventory of geographic, systematic and ecological data concerning the biota and ecosystems of Western Australia.	• Completed the development of the State census of WA plant taxa (WACENSUS). • Completed the inventory of the State's Reference Plant Collection; each reference specimen is now linked to a barcoded voucher in the main Herbarium. • Co-operated with the Western Australian Museum to commence a biological survey of the Irwin-Carnarvon region. • Completed the repackaging, labelling and identification of all specimens in the State collection of Bryophyta. • Completed the databasing of all specimens in the State collection of Lichens. • Held training workshops on the computer recording and management of descriptive taxonomic data.

Achievements of the Community Resources Section

Community Resources Section is committed to defining an appropriate system of conservation reserves for the State, identifying threatened ecological communities, and implementing a basis for managing change in ecosystems.

Dr Allan Burbidge
Section Manager

OBJECTIVES	ACHIEVEMENTS
To discriminate and document plant and animal communities so as to design a representative, adequate and comprehensive conservation reserve system.	• Finalized and submitted for publication a bibliography of location-based ecological information. This will provide land managers with much improved access to the literature on site-based biological studies in WA. • Commenced a broad scale survey of the northern Irwin and southern Carnarvon Phytogeographic Districts in order to document patterns of occurrence of plants and animals and assess the adequacy of the conservation reserve system in the area. • Completed and published or submitted for publication four Goldfields Cell reports: Part 7: Duketon - Sir Samuel, Part 8, Kurnalpi-Kalgoorlie, Part 9, Norseman-Balladonia and Part 10, Sandstone-Sir Samuel and Laverton-Leonora. Most Eastern Goldfields quadrats are now permanently locatable using GPS. • Commenced a floristic survey in the floristically diverse Coolcalalaya area, to assess gaps in the conservation reserve system and determine whether Beard's boundary between the Irwin and Carnarvon regions is in fact reflected in floristic patterns. • Provided input on issues in reserve system design as part of the National Forest Policy. Provided significant input into the Federal Government's Interim Biogeographic Regionalization of Australia (IBRA). • Maintained and updated a biological bibliography of the Pilbara Region.
To identify those communities with conservation significance that are rare or threatened.	• Established more than 500 floristic quadrats on the Swan Coastal Plain in a joint project with the Wildflower Society of WA to determine regional floristic patterns which can be compared with existing models of vegetation. The data provide a regional overview of floristic variation which can be used to assess the adequacy of the nature conservation reserve network on the Swan Coastal Plain and assist in land use decision making. • Undertook field surveys to obtain information for *"A Directory of Important Wetlands in Australia"* (ANCA 1993) and compiled the Western Australian chapter of this document.

OBJECTIVES	ACHIEVEMENTS
	• Undertook NPNCA-funded field surveys of frog and breeding waterbird distributions to complete the ANCA-funded inventory of south coast wetlands. • Commenced a broad scale survey of the northern Irwin and southern Carnarvon Phytogeographic Districts, enabling identification of communities of conservation significance. • Published a report on waterbird use of wetlands on the Swan Coastal Plain and papers on aquatic invertebrates of Two Peoples Bay Nature Reserve, annual survival rates and hunting mortality of ducks in WA, and waterbird use of wetlands in South-Western Australia according to wetland characteristics. • Completed a survey of aquatic invertebrate and waterbird communities of Arafura Sea mudflats, Kimberley. Surveyed Magpie Geese and other waterbirds in the Kimberley and completed a report. • Completed plant identifications and data entry for the floristic survey of coastal communities of the Warren botanical subdistrict and commenced analysis. Commenced a regional overview of plant communities to enable better informed land use decisions in this area. • Commenced data analysis and report preparation on the flora and vegetation of the Mt Windell transport corridor to fulfil the Dept of Environment Protection's guidelines for a Consultative Environmental Review. • Completed the Scott Plains rare flora survey. • Rediscovered three species of plants previously believed to be extinct: *Meziella trifida*, *Schoenus natans* and *Tetraria australiensis*. • Contributed four chapters to a book on the biology and conservation of the Stirling Range National Park. • Completed a review of the phytogeography of North West Cape. • Commenced a biological survey of the Barlee Range Nature Reserve in the Ashburton Phytogeographic District. • Investigated floristic patterns in the Menzies and Warren Botanical Subdistricts to provide a regional overview for use in land management decisions; data collection and analysis complete and write-up near completion. Communities identified in the tingle forest include some vulnerable to frequent fire and others vulnerable to *Phytophthora*. • Extended a dictionary of bat sonar calls and eco-morphology and foraging strategies, so as to increase the efficiency of sampling and identification of bat communities.

OBJECTIVES	ACHIEVEMENTS
	• Surveyed ecologically the remaining group of unsurveyed islands in Exmouth Gulf. • Completed a field survey of flora and fauna of Koolan Island and commenced analysis. • Obtained funding from Heritage Council of WA for floristic survey of Goldfields woodlands. • Analysed floristic data from lateritic uplands of the Mt Lesueur area.
To implement a basis for measuring change in ecosystems across the State so that the determination of management priorities is explicit.	• Commenced a broad scale biological survey of the northern Irwin and southern Carnarvon Phytogeographic Districts. • Established database of site-based Eastern Goldfields vertebrate and vascular plant records. Most Eastern Goldfields quadrats are now permanently locatable using GPS. • Completed field work for wet-season monitoring of east Kimberley, monitoring transects through several rainforest patches and re-sampled those at Mitchell Plateau. Installed a cattle-proof fence on Cape Bougainville to protect rainforest patches. • Reached agreement with some developers and their consultants on the need to establish standard methodology for sampling the Pilbara biota.

SCIENCE PROJECTS: COMMUNITY RESOURCES SECTION

Name	SPP* No	Title (Abridged)	Anticipated Outcome
Abbott I	93/21	Invertebrate conservation in an urbanized landscape: the native earthworm fauna of the metropolitan sector of the Swan Coastal Plain and its representation in the conservation estate.	Assessment of the conservation status of the native earthworm fauna in the Perth metropolitan region.
Burbidge AH	93/33	A biological survey of the Boonanarring Nature Reserve and adjacent bushland	Assessment of biota and draft management guidelines for this Reserve which has high conservation value.
Burbidge AH	93/34	A biological survey of Cape Arid National Park	Assessment of flora and provision of vegetation maps to assist drafting of management guidelines for biota in the 29 9415 ha Cape Arid National Park.

* SPP = Science Project Plan

Name	SPP* No	Title (Abridged)	Anticipated Outcome
Burbidge AH	93/35	Biological survey of the Southern Carnarvon and Northern Irwin phytogeographic districts in WA	Assessment of conservation value of diverse landforms in the 7.5M ha basin, based on flora, vertebrate animals and fresh water invertebrates. Information will form the basis for reserves selection and preparation of management prescriptions of reserves and other lands.
Burbidge AH	93/36	Assessment (in a regional context) of conservation values of VCL near Coolcalalaya	Assessment of biota so that this vacant Crown land can be assessed for addition to the conservation estate. Base line information will assist preparation of draft management prescriptions.
Gibson N	93/37	Floristic survey of the coastal communities of the Warren botanical subdistrict	Identification and mapping of vegetation units on the southern fringes of the karri forest area. Assessment of their conservation values and the status of rare taxa in the region.
Gibson N	93/38	Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain	Identification and mapping of vegetation remnants, distribution and occurrence of rare taxa to assist in preparation of management plans.
Halse S	93/23	Survey of Magpie Geese and other waterbirds in the Kimberley	Assessment of conservation needs of Kimberley waterbirds.
Halse S	93/24	Giardia in Straw-necked Ibis	Management of disease in Straw-necked Ibis.
Halse S	93/162	Aquatic invertebrate surveys and atlas	Systematics and inventory of Western Australian invertebrate fauna; their habitat preferences and conservation status.
Halse S	95/6	Monitoring river health initiative - Western Australia	Improved knowledge of the aquatic invertebrate fauna of the State and the pattern of occurrence of different communities. Provision of a method of assessing change in stream ecosystems as a result of land disturbance, management action or natural disaster.
Hopkins A	94/3	Regional assessment of the conservation status of vegetation units throughout Western Australia	Delineation of vegetation types in Western Australia (update of JS Beard's maps).
McKenzie N	93/25	Eastern Goldfields survey	Provision of essential information on flora and vertebrate animals to assess the conservation value of diverse landforms in the area. Information will form the basis for selection of further reserves and the preparation of management prescriptions.

Name	SPP* No	Title (Abridged)	Anticipated Outcome
McKenzie N	93/26	Rainforest management and monitoring	Management strategy for conserving rainforest patches in Kimberley Region from degradation.
McKenzie N	93/27	Buccaneer Archipelago survey	Assessment of biota and provision of base data for development of management strategies.
McKenzie N	93/28	Ecomorphological clues to community structure	Improved methods of surveying and monitoring ecological communities.
McKenzie N	93/29	Mandora Palaeoriver/Radi Hills survey	Assessment of biota of a diverse nature reserve which includes a Ramsar wetland and development of draft management guidelines.
Pearson D	93/32	Preliminary survey of the biological and cultural resources of the ranges of the Western Desert	Assessment of biological and cultural assets, location of endemic and threatened biota and ecological communities to enable formulation of recommendations for future land use.
van Leeuwen S	93/30	Biological survey of the Barlee Range Nature Reserve	Documentation of nature conservation values and development of Interim Guidelines for Operations.
van Leeuwen S	93/31	Botanical survey of central Pilbara uplands within the Karijini National Park	Determination of plant species of conservation significance and identification of areas warranting special management protection. Management prescriptions for retaining stands of mulga.
Wardell-Johnson G	93/39	Landscape modelling of vegetation communities of the Kent, Hay, Bow and Denmark River catchments	Provision of an effective method of analysis of geographically based information, based on a comparison of different techniques to model vegetation and associated wildlife communities.

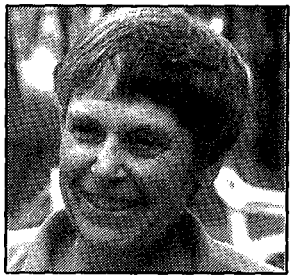
FUTURE DIRECTIONS

Discrimination and documentation of plant and animal communities across Western Australia continue to be the main thrust of work carried out in the Section. This assists in identifying those communities of conservation significance and those that are at risk. Design of a representative, adequate and comprehensive reserve system will continue to be a high priority, but increasing effort must be put into encouraging off-reserve conservation. Ongoing consideration is being given to determining priorities for documentation of plant and animal communities across the State. In the next few years, most effort will go into terrestrial communities in the Carnarvon Basin, the Pilbara, the Swan Coastal Plain and in aquatic communities (rivers and streams) throughout the State. Advice will be provided for other areas (including forest areas) as required, depending on CALM priorities. Data will be gathered in such a way as to facilitate possible future monitoring of changes in the occurrence of species and communities.

Co-operative projects with the WA Museum are being further developed to integrate the activities of the Section with those of the Museum.

Achievements of the Species Resources Section

Species Resources Section is committed to discriminating and describing the native biota of Western Australia, and developing and maintaining databases of easily retrievable taxonomic and ecological data.



Judy Wheeler
A/Section Manager

OBJECTIVES	ACHIEVEMENTS
To undertake systematic research to discriminate, describe and classify WA taxa with particular reference to those with: - conservation value; - economic importance and which can be sustainably utilized.	• Prepared research publications describing many new WA plant taxa and assessing their taxonomic relationships. Of particular note were treatments involving the genus *Acacia* and the families Asteraceae, Rhamnaceae and Tiliaceae. • Published the *Flora of the Kimberley Region*, a book with keys, illustrations and descriptions of the 2085 higher plant species of the region. • Commenced preparation of a user friendly Flora to enable identification of all flowering plant species of the south west forest areas. • Began preparation of a guide to the tree species of the south western forests. • Commenced data gathering to produce a computer key to the estimated 1400 genera of the State's flora. • Contributed to the *Flora of Australia* project, notably genera in the families Rutaceae, and a substantial part of the treatment of Australian *Acacia*. • Updated and maintained CALM's corporate database of descriptive information on the State's Declared Rare and Priority Flora Lists. • Published taxonomic studies on species of flora which have conservation significance. • Commenced a new initiative to describe all new species and subspecies which have conservation significance. • Completed the update of names of all collections of the plant family Cyperaceae in the State Collection. • Continued data compilation for seabird breeding islands database and mammal records for Australian islands database. • Completed a three year project on the impact of *Giardia* in Straw-necked Ibis populations. • Documented the distribution of the terrestrial amphipod fauna of Australia and the biology of several species of butterflies in Western Australia.

OBJECTIVES	ACHIEVEMENTS
To develop and maintain appropriate interconnected database systems for the capture and manipulation of taxonomic and biological data.	• Maintained data and entered details of all recently collected specimens onto the plant specimen database, WAHERB. • Progressed the capture of taxonomic information onto the taxonomic publications database, WALIB. • Maintained the Census of Western Australian Plant Names database (WACENSUS) and captured information on all newly published taxa of Western Australian flora. • Developed and implemented methods of capture and management of descriptive taxonomic data (the DELTA software). • Facilitated departmental access to published DELTA databases such as Flowering Plant Families of the World, Eucalypts of Australia, Sedge Genera of the World. • Designed and implemented a project to database information for a data dictionary of published and unpublished biological information on the State's flora • Completed the databasing of the State collection of fungi. • Commenced databasing of the Herbarium's estimated 5000 collections of algae. • Developed project design and commenced information capture for a data dictionary of biological information residing within the Department. • Progressed to near completion the databasing of the WA Herbarium's voucher specimen collection (WAHERB).

SCIENCE PROJECTS: SPECIES RESOURCES SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Burbidge AA	93/16	Taxonomic revision of *Beaufortia* R.Br.	Discrimination and documentation of species in a high profile genus.
Burbidge AA	93/17	Database of mammal records from Australian islands	Rapid assessment of possible impact of threatening processes such as introductions of feral predators or oil spills.
Burbidge AA	93/18	Seabird breeding islands database	Rapid assessment of possible impact of threatening processes such as introductions of feral predators or oil spills.
Chapman A	93/14	Publication of the Census of Western Australian plants	Authoritative list of current names for every plant species recorded in Western Australia.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Friend T	93/15	Systematics, zoogeography and phylogeny of the terrestrial Amphipods of Australia	Identification key, distribution maps, and assessment of the conservation status of the WA component.
Lander N	93/5	WA Flora Descriptive database research and pilot development	Quality, up-to-date, portable database; improved availability of information relating to the WA flora.
Lander N	93/6	Taxonomic studies in the Asteraceae, tribe Asterineae	Discrimination and documentation of species in the largest genus of Asteraceae, tribe Astereae.
Macfarlane T	93/8	Taxonomy and inventory of WA flora: legumes, grasses and lillies	Clarification of nomenclature and review of conservation status.
Macfarlane T	95/8	Taxonomy of new, rare and priority plant species of the southern forests	Establishment of the facts about the identity, distribution and conservation status of plants for operations staff and scientists dealing with the regional flora.
Macfarlane T	95/9	Taxonomic database of WA plant genera	One-stop taxonomic and descriptive information resource for WA flowering plants at the generic level. It will offer a means of identifying plants to genus level, obtaining a description of the appropriate level of detail, and it will be current and authoritative. It will also provide descriptions for other taxonomic publications.
Maslin B	93/1	Systematics of Western Australian species of *Acacia*	Discrimination and documentation of species in the largest plant genus in Western Australia.
Maslin B	93/2	Biological database	Protocols devised for a Corporate data register.
Maslin B	93/3	*Stylidium*	Updated database for the genus *Stylidium*.
Maslin B	93/4	Use of external taxonomic expertise	Improved state of taxonomic knowledge of the biota.
Maslin B	93/7	Systematics and conservation status of Western Australian taxa of the genus *Tetratheca* (Tremandraceae)	Improved identification aids, updated database and GIS to assist field management.
Maslin B	95/10	Flora of Australia treatment of *Acacia*	Synoptic treatment of all taxa of *Acacia* in Australia.
Perry G	93/9	Assessment of the taxonomic and nomenclatural problems associated with the "Declared Rare and Priority Flora List"	Up-to-date, authoritative list of primary information underpinning CALM's conservation program.
Rye B	93/10	Taxonomic review and conservation status of Western Australian members of the family Rhamnaceae	Accurate names of species and computerized register of the location of all specimens.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Rye B	93/11	Taxonomic studies of species on the "Declared Rare and Priority Flora List"	Formal description of listed unnamed taxa and clarification of geographical variation in each taxon.
Wheeler J	93/12	Gendata (A generic flora and descriptive database)	Ready means of identifying plants to genus.
Wheeler J	93/13	Flora of the lower south west	Descriptive database of 2500 taxa, as a means to publishing lists of species in National Parks and elsewhere where there is high public demand for information.
Williams M	93/22	Conservation status of butterflies in Western Australia	Preliminary list of representation of WA's butterfly species in National Parks and Nature Reserves.

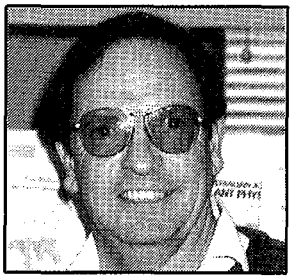
FUTURE DIRECTIONS

The development of an integrated system for the capture, interrogation, manipulation and presentation of descriptive taxonomic data has had a major influence upon the work of the Section. Future development and refinement of this system, particularly its dynamic connection to other databases (containing names, geographic and biological information) is the major challenge for the future. GIS applications and the use of CD-ROM are currently under development and these methodologies will undoubtedly be progressed, greatly enhancing our ability to analyse, present and disseminate information pertaining to the biological diversity of the State.

The taxonomic work on the biota of Western Australia is a major activity of the Section, however, greater emphasis is being placed upon taxa of conservation and potential economic importance. Of particular significance for future work is the cryptogamic flora which has been largely ignored in the past. The recent move to resolving high-priority taxonomic problems by contracting experts has proved to be both efficient and cost-effective, and will continue. Integrating the taxonomic work of the Section with other Departmental projects, and making the results of this research more readily available and relevant to these projects, remains a high priority and will be further developed in the future.

Achievements of the Bio-conservation Group

Bio-conservation Group is committed to reversing the direction of many species of native biota towards extinction, by overcoming threatening processes.



Dr Tony Start
A/Head of Group

OBJECTIVES	ACHIEVEMENTS
To concentrate effort and resources on the most important (not necessarily the most topical) problems of biological conservation facing CALM.	• Reviewed all active research programs and reallocated resources to highest priority areas. • Reviewed the Group's objectives, strategies and outcomes. • Encouraged and facilitated scientists' contributions to integrated research across groups, eg. Kingston timber harvesting project.
To review scientific knowledge of topics that are relevant to biological conservation and pertinent to CALM.	• Focussed the large program of research on fungal diseases conducted under external funding. • Co-authored an application for a CRC to address control of *Phytophthora* diseases. If successful the CRC will be located in WA and managed by CALM.
To deliver information and support to other sectors of CALM which require or will benefit from specialist advice and scientific data.	• In co-operation with the APB, continued active research on fox control under the auspices of the CRC for Bio-control of Vertebrate Pests. • Established the monitoring program for Operation Foxglove. • Achieved specified progress on the research components of Recovery Plans for threatened biota and liaised with WATSCU on development of new Recovery Plans.
To contribute to scientific knowledge and community appreciation of conservation biology and CALM's mission and achievements.	• Contributed papers to numerous national and international journals as well as *CALMScience* and presented papers to conferences round Australia. • Contributed extensive to CALM's objectives through advice to operations staff, and through advice to other Divisions, input to Management Plans and contributions to the activities of Corporate Relations Division, especially through LANDSCOPE.

Achievements of the Community Conservation Section

Community Conservation Section is committed to understanding and overcoming the many processes which threaten the persistence of the State's ecological communities.

Dr Gordon Friend
Section Manager

OBJECTIVES	ACHIEVEMENTS
To understand the processes determining the structure and stability of terrestrial and aquatic biological communities and their resilience to change.	• Collected long-term data on the diversity and composition of small vertebrate and invertebrate communities inhabiting mallee-heath and woodland habitats in the south-west, together with information on the structure and composition of vegetation. • Assembled information regarding resilience to disturbance in relation to climate, and the relative importance of fire, season, locality and year-to-year variability in climate and stochastic events (eg. drought) in determining the structure and composition of faunal communities. • Continued assessment of post-fire regeneration and flowering in permanent quadrats located in spring, summer and autumn burnt plots at Stirling Range National Park. • Monitored the survival and height growth of *Hakea crassifolia* seedlings, and the development of on-plant seed stores in relation to time since last fire. • Completed database for distribution of bridal creeper as a first step in climatic and GIS modelling. • Completed monitoring of understorey plants in quadrats in salmon gum *Eucalyptus salmonophloia* woodland from which sheep were excluded. • Completed a 4 year study on the biological attributes and compositional differences between mulga woodlands in the central Hamersley Ranges. • Placed floristic pattern of Walpole-Nornalup National Park in a Regional perspective. • Placed bird communities of Walpole-Nornalup National Park in a Regional perspective. • Developed a fire-response data base for fire management planning and determining priority taxa for population studies and conservation.

OBJECTIVES	ACHIEVEMENTS
To determine the impact of threatening processes and human induced disturbances on the structure and function of biological communities, and define the technology and management practices required to ameliorate the effects of these agents.	*Fungal pathogens* • Demonstrated that *Diplodina* disease is caused by a new species of *Cryptodiaporthe* and that it produces wind-borne ascospores and splash-borne conidia; commenced inoculation experiments to determine how infection occurs and which factors will trigger symptom expression. • Commenced investigations to determine whether burning offers a management option for *Banksia coccinea* stands infested by *Cryptodiaporthe* • Quantified the *in vitro* sensitivity of *Phytophthora megasperma* to the fungistatic control agent phosphonate and tested the efficacy of phosphonate in retarding the damage and spread of the disease caused by *P. megasperma.* • Quantified morphological variability exhibited by *P. megasperma* isolates retrieved from diseased areas of WA bushland. • Showed that phosphonate controls *P. cinnamomi* in susceptible native hosts and determined effective dosage. • Developed and commenced testing the hypothesis that combined spray, injection and boost spray of phosphonate could be used to control *P. cinnamomi* in infested sites. • Completed bioassay of the activity of phosphonate - examined the effect of heat, phosphate and phosphite on the *in vitro* growth of four isolates of *P. cinnamomi.* • Examined intraspecific variation within *Armillaria luteobubalina* in order to explain current high impact. • Determined *in vitro* sensitivity of various stages of the life cycle of local isolates of *P. citricola* to phosphonate. • Determined the seasonal effects of soil water and temperature on survival of *P. citricola* and demonstrated variation in pathogenicity between isolates of *P. citricola* using cloned jarrah seedlings. • Identified canker fungi recovered from 198 plant taxa from the south west considered to be under threat from plant diseases. Fungi were isolated from 1259 cankers on 508 samples. • Targeted Declared Rare Flora considered to be under threat from plant diseases for seed collection and micropropagation. Shoots, and in some cases seed, of 10 species from 17 populations were collected and supplied to laboratories at Kings Park for micropropagation.

OBJECTIVES	ACHIEVEMENTS

Fire

- Collected empirical data regarding the effects of fire on small mammals, herpetofauna and selected invertebrates in mallee-heath and woodland habitats of the south-west.
- Derived an understanding of the relationship between species' life history strategies (particularly their requirements for shelter and food and their reproduction patterns) and their response to fire and other human-induced disturbances.
- Assembled information on the relative importance of the various components of a fire regime (scale, intensity, frequency and season) in determining the impact of fire on faunal communities, with recommendations for optimal fire regimes in various areas.
- Developed a model to predict the impact of fire on small vertebrate species, based on their life form category (shelter, food and reproductive requirements). Assembled a database on vertebrate life history patterns for use in conjunction with this model.
- Continued to assess the response of terrestrial vertebrates to prescribed spring fires and wildfires in hummock grasslands in the Great Victoria Desert.
- Completed pre-fire monitoring for an eight year project investigating the effect of fire on mulga woodlands in the central Hamersley Range.
- Developed and defined operational procedures for hazard reduction and controlled burning program in and adjacent to mulga communities in Karijini National Park
- Set up and outlined criteria for environmental value maps as part of the Wildfire Threat Analysis action plan for Karijini National Park.

Wetlands

- Determined location of surface water inputs to Lake Clifton and measured nutrient loadings in these and lake waters.
- Monitored water quality of 65 wetlands in National Parks and Nature Reserves of south-western Australia.
- Gained funding for and commenced an assessment of the role and importance of the Vasse-Wonnerup floodplain in the maintenance of waterbird populations.
- Reviewed the scientific literature concerning requirements for effective buffering of wetland ecosystems from degrading influences.
- Prepared draft guidelines for design of effective buffers for wetlands on the Swan Coastal Plain.

OBJECTIVES	ACHIEVEMENTS
	• Analysed the results of six years of experimental outflows from the Yenyenning Lakes and prepared a final report and recommendations concerning future management.
To identify the ramifications of ecological impacts at the landscape and ecosystem level and develop the scientific basis for the conservation and rehabilitation of integrated landscape systems.	• Determined the distribution of *P. citricola* in relation to tracks in the northern jarrah forest (in conjunction with Alcoa of Australia Limited and Murdoch University). • Mapped the extent of burning on the Lake Johnson and Malcolm 1:250 000 map sheets from successive air photo runs and satellite images between 1960 and 1992, and converted data to a digital form suitable for analysis using a geographic information system. • Collected tree stem sections of *Eucalyptus, Callitris* and *Actinostrobus* from areas of known fire history in the Lake Johnson and Malcolm areas to cross-date fire patterns observed on air photographs and satellite images. • Organized and conducted a workshop on the introduced weed *Watsonia* and edited the Proceedings. • Contributed to the review of the edited Departmental Policy on bushland weeds and represented CALM on the State Weeds Strategy Steering Committee. • Initiated post-fire monitoring of fire on mulga woodlands. Constructed 35 km of fire breaks and low fuel buffers around nine treatment plots. • Tested a prototype GIS-based model of assistance in monitoring and controlling the spread of *Phytophthora* and the management of *Phytophthora*-sensitive taxa and communities.

SCIENCE PROJECTS: COMMUNITY CONSERVATION SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Bathgate J	93/67	Control and management of stands of *Banksia coccinea* infected with *Diplodina* sp	Basis for management of diseased populations, particularly using appropriate fire regimes.
Bellgard S	93/79	The control and management of *Phytophthora megasperma* in the National Parks and Nature Reserves of WA	Means of minimizing the spread of the disease.
Bunny F	93/82	Biology and control of *Phytophthora citricola* in native plant communities affected by mining	Development of management options for minimizing spread of the disease and devising of a method of determining risk of infection.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Burrows N	93/160	Using prescribed fire to rehabilitate landscapes disturbed by mining exploration in the arid zone	Development of an appropriate fire regime to promote landscape rehabilitation following exploration for mining in Rudall River National Park.
Friend G	93/72	Effects of prescribed burning on invertebrate communities in Durokoppin and East Yorkrakine Nature Reserves	Development of an appropriate fire regime to maximize conservation of invertebrates in remnant semi-arid nature reserves.
Friend G	93/73	Effects of three fire regimes on ground-dwelling invertebrates in jarrah forest	Recommendation of an appropriate fire regime to maximize conservation of selected soil and litter invertebrates in jarrah forest.
Friend G	93/74	Effects of prescribed burning on small vertebrates in Tutanning Nature Reserve	Development of an appropriate fire regime to maximize conservation of small vertebrates in remnant (wheatbelt) nature reserves.
Friend G	93/75	Effects of spring and autumn prescribed burns on small vertebrates in jarrah forest	Recommendation of most appropriate fire regime to maximize conservation of small vertebrates in jarrah forest.
Friend G	93/76	Prescribed burning and the conservation of invertebrate communities in the jarrah forest of Western Australia	Recommendation of most appropriate fire regime to maximize conservation of selected vertebrates in jarrah forest.
Gibson N	94/13	Monitoring of the effects of the Dawesville channel on the vegetation of the Peel - Harvey estuary	Accurate and detailed information of the changes in vegetation surrounding the Peel - Harvey estuary during the first five years after the opening of the Dawesville channel. Early identification of degradation and implementation of remedial management options. Large populations of DRF are found fringing freshwater wetlands of Austin Bay.
Hopkins A	93/90	Effects of fire on plant species and communities at Tutanning Nature Reserve (A25555)	Development of an appropriate fire regime to maximize conservation of plants in remnant semi-arid nature reserves.
Hopkins A	93/91	Development of the Departmental monitoring program	Development of a practicable protocol for monitoring of biota on CALM's estate.
Hopkins A	93/165	Ecological studies, Lesueur National Park (and adjacent areas)	Basis for management of rare plant species and circumscription of ecological units.
Komorek B	93/81	Control and management of *Phytophthora cinnamomi* in native plant communities	Protocols for application of phosphonate fungicide to control the disease.
Lane J	93/58	Quantitative field assessment of nutrient inputs by surface runoff into Lake Clifton (Yalgorup National Park), an internationally significant wetland	Scientific basis for determining minimum vegetated buffer widths (relative to surface nutrient inputs); characterization and quantification of nutrient sources.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Lane J	93/59	Development of guidelines for monitoring of Australia's wetlands of International importance (Ramsar Convention)	Monitoring protocols for WA wetlands.
Lane J	93/60	Monitoring of wetlands in nature reserves and National parks of south-western Australia	Evaluation of management actions impacting on depth, salinity, pH, nutrients and vegetation.
Lane J	93/61	Assessment of the role and importance of the Vasse-Wonnerup floodplain in the maintenance of waterbird populations	Realistic conservation strategy for wetlands near Busselton.
McCaw L	93/85	Post-fire response in mallee-heath shrubland at Stirling Range National Park	Development of an appropriate fire regime to maximize regeneration of plant species after fire.
McCaw L	93/86	Fire induced mosaics in semi-arid shrubland and woodland communities	Assessment of whether fire frequencies in unmanaged areas permit satisfactory regeneration of plant species, and assessment of the effectiveness of patch burning in limiting spread of wildfires.
Pearson D	93/92	Fire effects on desert vertebrates - influence of fire season	Development of an appropriate fire regime to maximize conservation of vertebrates in hummock grassland.
Pigott P	93/77	Bridal creeper (*Myrsiphyllum asparagoides*) control and ecology in Western Australia	Means of minimizing the spread and impact of this weed.
Pigott P	93/78	Ecology of understorey communities and soil seed-bank of remnant salmon gum (*Eucalyptus salmonophloia* F.Muell) woodland near Lake Taarblin, WA	Protocols for regenerating and rehabilitating degraded remnants of salmon gum woodland.
Shearer B	93/68	Integrating strategies for control of *Phytophthora cinnamomi* with phosphonate	Improved prescriptions for control of the disease using phosphonate fungicide.
Shearer B	93/69	Use of debilitating factors and host resistance to control *Diplodina* canker in *Banksia coccinea* communities	Protection of *B. coccinea* from *Diplodina* infection. Resistance could be incorporated into selections for the cut flora industry.
Shearer B	93/70	Control and management of *Armillaria luteobubalina* in native communities	Improved management of *Armillaria.*
Stukely M	93/80	Rapid identification of species of *Phytophthora*	Quicker means of identifying species of *Phytophthora* and improved characterization of variability in each species.
van Leeuwen S	93/141	Fire-Mulga study: burn and post-fire monitoring	Development of an appropriate fire regime to maximize conservation values of mulga communities.
Wardell-Johnson G	93/87	Community conservation of the Walpole Nornalup National Park	Mode of regeneration of several hundred plant species after fire.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Wardell-Johnson G	93/88	Community conservation of the Lake Muir complex	Quantitative data on the regional distribution of several hundred plant species.
Wardell-Johnson G	93/89	Conservation biology of locally endemic eucalypts	Data on genetic variability, response to fire, and distribution of four eucalypt species.
Wills R	93/49	Development of GIS-based decision support tools in the control of *Phytophthora* and the management of *Phytophthora*-sensitive taxa and communities	Development of an expert system for use by land managers.

FUTURE DIRECTIONS

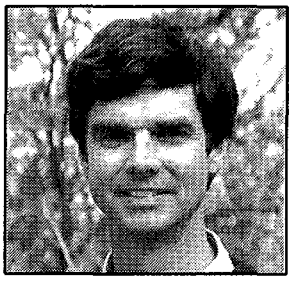
Future research within the Community Conservation section will continue to focus on understanding the processes underpinning community structure and resilience, in both terrestrial and aquatic systems, and the impact of disturbance or threatening processes on these communities. Although the emphasis in terrestrial disturbance ecology research has in the past been primarily directed at fire, this emphasis will broaden to encompass work on the impact of timber harvesting and dieback diseases on faunal communities, and the predictive modelling of response patterns. This work needs to be accompanied by increased acquisition of physical resource information through the use of Geographic Information Systems. Emphasis in aquatic systems will relate to understanding the ramifications of land and water management practices (eg. the Dawesville cut) and the impacts of development on aquatic biota.

Research on plant diseases will continue to focus on strategies for control using phosphonate, with increased emphasis on gathering basic epidemiological data on *Phytophthora* spp, particularly in the south coastal shrublands.

Further research areas requiring increased attention relate to the biology and impact of weeds and rehabilitation of degraded communities. Weed research needs to concentrate on the basic biology of selected major weeds, their interaction with fire, and the processes underlying their impact on terrestrial and aquatic native plant and animal communities. Research on rehabilitation would need to be multidisciplinary, focusing on techniques for re-establishing degraded communities, while other work would need to be integrated with that of WATSCU to address potential impacts on threatened communities.

Achievements of the Species Conservation Section

Species Conservation Section is committed to understanding and overcoming the many processes which threaten the survival of many of the State's species of native biota.



Keith Morris
Section Manager

OBJECTIVES	ACHIEVEMENTS
To develop the protocols required for the conservation of threatened and other priority conservation taxa in WA.	• Prepared Recovery Plans for Chuditch, Numbat, Shark Bay Mouse, Western Mouse, *Geocrinia* frogs, Woylie, Tammar, Brush-tailed Rock Wallaby and Western Swamp Tortoise, Noisy Scrub-bird, Rose Mallee, Wongan Hills Trigger plant, Quairading Banksia and Purdie's Donkey Orchid. • Prepared a research plan for Western Whipbird, Western Bristlebird and Ground Parrot. • Published Wildlife Management Programs for rare and threatened flora in the Merredin District and Metropolitan area. Completed draft Management Programs for rare and threatened flora in the Albany and Esperance Districts. Commenced preparation of Wildlife Management Programs for rare and threatened flora in remaining southern Districts. • Prepared Interim Wildlife Management Guidelines for Thevenard Island Mouse, Lancelin Island Skink and Western Ringtail Possum. • Developed successful translocation protocols for Numbats, Chuditch, Shark Bay Mouse, Western Ringtail Possum and Noisy Scrub-bird. • Completed research into abundance and distribution of the Shark Bay Mouse on Bernier Island. • Commenced studies into the conservation biology and status of pythons, Lancelin Island Skink, and Western Bristlebird; continued with marine turtle studies; and added the Loggerhead Turtle to the Specially Protected Fauna list. • Completed research and drafted publications on management issues affecting the conservation of the Nullarbor Quail-thrush. • Completed and published research on population genetics, mating systems and conservation of threatened *Banksia* and *Stylidium* species, and *Geocrinia* frog species. • Completed population biology research on threatened *Banksia* and *Eucalyptus* species. Commenced research on threatened *Lambertia, Dryandra, Stylidium, Eremophila* and orchid species.

OBJECTIVES	ACHIEVEMENTS
	• Commenced research into the seed biology and seed bank dynamics of threatened flora species. • Initiated population monitoring programs for the Lesser Noddy, Greater Stick-nest Rat, Numbat, Chuditch and endangered flora. • Developed monitoring protocols for nesting marine turtles and management guidelines for protection of rookery areas from ecotours and the oil industry.
To identify the processes that detrimentally impact on the native biota and develop strategies for the control of these processes.	• Commenced an investigation into the possible impacts of timber harvesting on Chuditch and other medium-sized mammal species. • Completed research that demonstrated that fox baiting benefits Chuditch and other medium-sized mammal species. • Completed research which demonstrated that exotic predators have played an important role in the decline of ground dwelling medium sized mammals in the semi arid and arid zone of WA. Initiated research into the impact of the fox on the arboreal Red-tailed Phascogale and Western Ringtail Possum. • Developed operational guidelines for the control of the fox in WA. • Commenced studies into the most appropriate broad scale fox baiting strategy and prey response in the jarrah forest and wheatbelt. • Commenced studies into the compensatory ecological responses of foxes to a reduction in population size. • Determined an effective bait/additive palatable to cats, following pen trials. Commenced research into the effectiveness of this for the control of feral cats. • Developed and implemented successful Black Rat eradication programs on Barrow and other Pilbara islands. • Completed study into the impact of the lerp *Cardiaspina* on Flat Topped Yate and existence of resistance in this eucalypt. • Identified threats to and the management required to conserve rare and priority flora in the Moora, Geraldton, Katanning and Narrogin Districts and Central and Southern Forest Regions.

SCIENCE PROJECTS: SPECIES CONSERVATION SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Algar D	93/46	Relative acceptability of bait materials to feral cats	Development of an effective bait to kill feral cats.
Algar D	93/47	Measuring the effectiveness of 1080 baiting to control feral cats	Assessment of efficacy of 1080 fox baits in killing feral cats.
Burbidge AA	93/63	Recovery plan for Western Swamp Tortoise	Increase in numbers in the wild of Western Swamp Tortoise.
Burbidge AA	93/71	Monitoring the total numbers of the Lesser Noddy (*Anous tenuirostris melanops*) in Australia and the numbers of some other seabirds breeding on Pelsaert Island	Detection of change in abundance of lesser Noddy nesting in Houtman Abrolhos.
Burbidge AH	93/64	Conservation status of the Nullarbor Quail-thrush	Increase numbers of threatened ground-dwelling bird species in the arid zone.
Burbidge AH	93/65	Conservation of the Western Bristlebird	Development of a strategy to increase numbers of a very restricted bird species.
Burbidge AH	93/66	Radio-tracking translocated Noisy Scrub-birds	Development of a strategy to determine the degree of establishment of relocated species..
Coates D	93/42	Conservation biology of Western Australia's rare and threatened flora	Preparation of Recovery Plans and wildlife Interim Management Guidelines for rare and threatened flora, and provision of essential information and protocols for the conservation and management of high priority and endangered plant taxa.
Coates D	93/43	Seed biology, seed bank dynamics and long term germplasm storage of Western Australian flora particularly rare, threatened and commercially utilized taxa	Provision of relevant information and protocols for conservation and management of rare, threatened and commercially utilized flora.
Coates D	93/44	Development and coordination of a quadrat based monitoring system for endangered flora	Early detection of decrease in abundance of endangered flora.
de Tores P	93/54	The effect of fox control of the utilization of habitat by the mainland Quokka (*Setonix brachyurus*)	Increased distribution and abundance of Quokkas in jarrah forest.
de Tores P	93/157	Control and ecology of the Red Fox in Western Australia - Prey response to 1080 baiting over large areas at three baiting frequencies	Development of cost-effective control of foxes.
Friend T	93/144	Quenda translocation methods	Development of translocation protocols for quendas.
Friend T	93/145	Factors affecting establishment in the Numbat reintroduction program	Improved area - specific protocols for management of habitat of numbats, resulting in increased abundance of numbats.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Friend T	93/149	An assessment of the effect of fox control on Red-tailed Phascogale populations	Development of baiting protocol to kill foxes.
Friend T	93/163	Genetics and ecology of the Western Barred Bandicoot	Development of protocols for increasing the abundance of Western Barred Bandicoots.
Kinnear J	93/83	FRNP mammal population responses to baiting	Development of baiting protocol to kill foxes.
Kinnear J	95/5	A conservation strategy for the western desert rock-wallaby	Reduced risk of extinction of a species that formerly occupied a large area. Should biocontrol become a reality, this species will be still extant allowing CALM to re-introduce the species throughout the Western Desert. Greater knowledge about the impact of exotic predators on priority fauna in a remote desert setting and the level of control needed to negate this impact. Re-introduction of a species to an island (Depuch) where it formerly occurred.
Marlow N	94/9	The development of microsatellite probes to investigate the social organisation of foxes	A more refined control method for foxes over large tracts of conservation estate, thus reducing the need for lethal baiting. As a consequence, threatened taxa will increase in abundance.
Lane J	93/62	Management of the Busselton wetlands: control of water levels and other perturbations and their impacts upon breeding of the Black Swan (*Cygnus atratus*)	Decreased nesting failure and mortality of Black Swans in Busselton wetlands.
Marlow N	93/57	Control and ecology of the Red Fox in Western Australia:	Provision of improved baiting regime for foxes.
Morris K	93/52	The conservation of the Thevenard Island Mouse *Leggadina aff. lakedownensis*	Increased abundance of Thevenard Island mouse.
Morris K	93/53	Recovery plan for the Chuditch (*Dasyurus geoffroii*)	Increased abundance of Chuditch.
Morris K	93/55	Reintroduction and monitoring of the Greater Stick-nest Rat on Salutation Island, Shark Bay	Re-introduction of Great Stick-nest Rats, a species previously extinct in WA.
Morris K	93/56	Recovery Plan for the Shark Bay Mouse (*Pseudomys fieldi*)	Increased abundance of Shark Bay Mouse.
Patrick S	93/45	Population surveys, conservation status and area based wildlife management programs	Summary of current knowledge of the rare, threatened and priority flora taxa for Moora, Geraldton, Katanning, Albany, Esperance and Narrogin Districts, Central Forest Region, Southern Forest Region, Darling Scarp endemics, and Shark Bay.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Pearson D	93/159	Ecology and conservation of Western Australian Pythons	Assessment of processes responsible for the decline in distribution and abundance of pythons, particularly *Morelia spilota imbricata*.
Pigott JP	93/48	Weed control in populations of Western Australia's rare and threatened flora	Development of practical methods to control weeds threatening native plant species.
Prince R	93/40	Conservation of marine turtles - Western Australian region	Documentation of breeding sites and monitoring abundance of breeding populations.
Prince R	93/41	Dugong conservation - Northern Western Australia	Improved knowledge of distribution, abundance, genetics and causes of mortality to underpin management of dugong populations in WA.
Wardell-Johnson G	93/93	Conservation biology of vulnerable frogs	Increased abundance and distribution of the two most restricted frog species in WA.

FUTURE DIRECTIONS

Many threatened species of flora and fauna occur in WA and much of the Section's work will be directed towards developing conservation strategies for these species. Involvement in the preparation and implementation of recovery programs for threatened taxa will continue to be an important function. Research relevant to the recovery of 38 percent of the State's extant specially protected vertebrate fauna is currently underway and it is likely that some of these will have their conservation status reduced over the next five years. Documenting the distribution and status of the threatened flora will continue, and management programs for all known threatened flora in the south west will be completed within five years. The close links with WATSCU in developing priorities for species conservation research will continue and research initiated on those most deserving.

There is also a need to examine the conservation status of taxa presently on reserve lists and to take action to upgrade their status if necessary. Invertebrate and marine species conservation requires more attention in the future. The assessment of the impact of vertebrate pests and weeds on threatened species will also continue to be an important function. Operational guidelines for the control of the fox will be finalized. Trials to determine an effective feral cat bait are currently underway and within a year the results will be applied to enhance the conservation of threatened mammals in arid and semi-arid areas. Recent significant achievements in species conservation programs will enable section members to become increasingly involved in self-funding ecotours, as well as participating further in operational fauna management programs.

Achievements of the Sustainable Resources Group

Dr Per Christensen
Head of Group

The Sustainable Resources Group is committed to ensuring that the biological resources of the State are used sustainably with minimal impact on the environment.

OBJECTIVES	ACHIEVEMENTS
To provide science-based information which will enable CALM to expedite its role in the sustainable utilisation of resources in the most cost-effective manner with the least possible disturbance to the environment.	• Completed the development of a fire behaviour and fire impact model for jarrah forest. • Commenced a major integrated study into the effects of timber harvesting operations in the intermediate rainfall jarrah forest ecosystem. • Developed preliminary estimates of sustainable harvesting levels for Brown Boronia (*Boronia megastigma*).
To identify, evaluate and participate in the development of new products from natural resources of Western Australia.	• Continued the major *E. globulus* tree breeding program with emphasis on the selection, breeding and propagation of the best material. • Commenced two large externally funded projects aimed at establishing more trees on farms. The Pine Timberbelt program aims to demonstrate the use of pine belts integrated within whole farm plane. The south-west land interpretation project aims to relate the performance of trees of farms to an array of soil and site factors. • Participated in the Conocurvone Research and Development Consortium; provided information on fire ecology of relevant species. • Commenced commercial development of oil mallees and initiated studies of breeding and propagation techniques. • Modified the silvicultural schedules for radiata pine plantations to maximize the production of wood by applying fertilizers at intervals during the rotation.

Achievements of the Natural Products Section

Natural Products Section is committed to understanding how native species (from which natural products are derived) can be utilized sustainably.

Dr Neil Burrows
Section Manager

OBJECTIVES	ACHIEVEMENTS
To evaluate and initiate the development of existing and new natural products, industries and markets.	• Collected further data on growth and survival to ensure that utilization of Brown Boronia is sustainable. • Assessed the suitability of the following species for the VALWOOD® process (in which thin boards are edge-glued and face-glued to produce furniture and joinery panels and the products themselves): Mountain Ash (*Eucalyptus regnans)* Rose gum (*E. grandis*) Spotted gum (*E. maculata)* Blackbutt (*E. pilularis)* Sydney bluegum (*E. saligna)* Yellow stringybark (*E. muelleriana)* Cypress Pine (*Callitris columellaris)* Marri (*E. calophylla)* Karri (E. diversicolor).
To provide the scientific information and to develop techniques to optimise the production and sustainable utilization of natural products.	*Pine* • Commenced testing the hypothesis that *Pinus radiata* is highly susceptible as seedlings to *Phytophthora cinnamomi* and in the juvenile stage for the first 4-5 years. *Karri* • Established an experiment to compare biological and chemical methods to control *Armillaria* in regrowth karri stands. • Showed from field observations, field surveys and a mill survey that both brown wood and rot are widespread in regrowth karri. • Defined brown wood in karri as incipient rot and showed that if left for long enough, white pocket rot or white rot will develop. Identified two of the fungi which can cause brown wood in karri. • Demonstrated that light traps could be used to capture bullseye borer and constructed an olfactometer to study pheromone preferences of bullseye borer. • Evaluated the success of in-fill planting of karri seedlings for regenerating karri stands on a range of sites. • Compared the growth performance of seedlings raised using a variety of nursery techniques.

OBJECTIVES	ACHIEVEMENTS

- Completed a major re-measurement of a thinning/fertilizer experiment in 25 year old karri regrowth and monitored the annual growth of 25 year old karri regrowth on a low rainfall site following thinning to a range of stand densities.
- Collaborated in an operational trial to evaluate the potential of helicopter ignition for prescribed burning thinning of slash in karri regrowth stands.

Jarrah

- Completed a study on the major factors affecting emergence, mortality and growth of jarrah from seed in the northern jarrah forest. Demonstrated that removal of overstorey improves survival and growth of seedlings because of greater water availability, more light and higher temperatures.
- Completed a study on the effects of thinning and fertilising on growth and physiology of jarrah pole stands. Demonstrated that the response to thinning was due to greater water availability and the response to fertilization was due to increased leaf area and leaf nutrient status.
- Initiated a series of experiments to determine the major factors affecting seed-fall, the fate of seed, emergence, survival and growth of jarrah in shelterwood cut jarrah forest.
- Completed a fire behaviour and fire impact model for jarrah forests: The model enables better predictions of fire behaviour and of important acute fire impacts which give rise to ecological responses and commercial losses.
- Completed screening of jarrah from the CALM provenance collection; selected and transferred resistant seedlings for initiation into tissue culture.
- Continued monitoring of field trials of clones after 5 year old resistant lines are performing well with 0-10% mortality, whilst susceptible lines have high mortality (40-100%).

Wildflower Industry

- Developed a cost-effective method of map and field census for the presence and abundance of Brown Boronia.
- Created an interactive computer program, BOROQUO, which helps District Managers and Wildlife Protection staff set commercial picking quotas.
- Collected preliminary data which suggests a link between stream pH and presence or absence of Brown Boronia.
- Established permanent plots at 10 sites throughout the range of Brown Boronia to yield data on effects of legumes, season of germination and wood ash on survival and growth of Brown Boronia.

OBJECTIVES	ACHIEVEMENTS
	Sandalwood • Created an interactive computer program for estimation of air-dry weight of heartwood given the outside dimensions of a sandalwood log. • Contributed to sandalwood inventory methods in Timor, which is relevant to the development of sandalwood plantations in the Kimberley region of WA *Wood utilization* • WURC staff assisted in the construction and commissioning of CALM's low cost solar dryers in the following sawmills: ◊ Bushmills Timbers, Kenwick (WA) Two 200 m^3 chambers; ◊ Goldfields Joinery and Timber Supplies, Kalgoorlie (WA) Two 150 m^3 chambers; ◊ Jamestown Sawmills, Jamestown (SA) Four 50 m^3 chambers; ◊ Mt Gambier Pine Industries, Mt Gambier (SA) Two 150 m^3 chambers; ◊ Harris Wood Machining, Busselton (WA) Three 30 m^3 chambers; ◊ Colli and Sons, Mundijong (WA) Four 130 m^3 chambers; ◊ Australian Design Hardwood, Woolbank (NSW) Two 30 m^3 chambers. • Developed drying schedules for 25, 38 and 50 mm regrowth marri in order to increase the efficiency of Western Australian timber producers drying schedules. Recommended drying schedules were circulated to industry for 15, 25, 38 and 50 mm regrowth and mature jarrah. • Surveyed the environmental conditions affecting behaviour of timber, which gains or loses moisture as the equilibrium moisture content (EMC) changes. Produced an EMC map showing zones of environmental moisture levels in different parts of the State.
To research the impacts of utilization on the resource and on the ecosystem in which it occurs.	*Karri* • Identified insect species collected from a light trap survey of Inventory to provide base line knowledge for future biodiversity studies in karri. • Examined the influence of remnants of mature forest in areas of karri forest harvested for timber.

OBJECTIVES	ACHIEVEMENTS
	• Revisited the priority of road, river and stream zones: Stream zones and adjacent forest are the most important areas for conservation in the karri forest. • Found that retained mature forest ameliorates the impact of harvesting timber on bird communities in karri forest. *Jarrah* • Showed that reducing the basal area of jarrah stands increased growth of *Phytophthora cinnamomi* inoculated in jarrah stems, especially in areas where jarrah experiences substantial summer drought. • Remeasured long-term forest transects established in 1928 and remeasured at intervals since then as part of monitoring long-term effects of forest management. • Found that jarrah stump coppice consumes more water than saplings of similar stem diameter. • Determined the effects of thinning on catchment hydrology over 9 years post- thinning. Demonstrated that thinning will greatly increase potable water supply from high rainfall jarrah forest. • Initiated a study to determine the characteristics of hollow-bearing jarrah and marri trees and coarse woody debris, their use by selected species of fauna, and the effect of logging-and-burning jarrah forest on them. • Completed contributions to a document "A Proposed Study of the Effects of Timber Harvesting on the Jarrah Forest Ecosystem" which outlined the multidisciplinary approach being taken in the work, and completed negotiations with relevant Regional and District personnel to commence the study in Kingston block. • Initiated fox baiting at Kingston block and established 20 trapping grids incorporating pitfall traps, Elliott aluminium traps and Sheffield wire-cage traps as part of this study. *Wildflower harvesting* • Commenced research into damage caused by wildflower pickers to *Boronia megastigma*. • Developed an interactive computer program BOROSYS, to explore and understand the ecosystem within which Brown Boronia occurs, and to synthesize research results as they come to hand.

OBJECTIVES	ACHIEVEMENTS
To develop the most effective and efficient management practices for utilizing the resource.	• Commenced re-analysis of site hazard rating for the impact of *Phytophthora cinnamomi* in northern jarrah forest. Selected sites in northern jarrah forest to determine whether phosphonate can increase the growth of jarrah in the presence of *Phytophthora cinnamomi.* • Completed a study on the efficacy of two herbicides on jarrah and marri trees and developed new practices for the application of this technique. • Collected seed, for rehabilitation purposes, from about 100 potentially-resistant jarrah trees surviving in old (mostly >25 yr) dieback graveyard sites in the northern jarrah forest.
To develop protocols for monitoring environmental impacts and sustainability of management practices.	*Insect outbreaks* • Completed a 7 year study of jarrah leafminer outbreaks and demonstrated that timber harvesting and prescribed burning have not promoted outbreaks. • Developed a theory that leafminer outbreaks may be contained by more broadscale scorching of jarrah crowns and set up an experiment to test this theory (5000 ha of jarrah forest near Collie burned in Autumn 1993). • Initiated a demonstration trial to evaluate the efficacy of retaining jarrah resistant to leafminer infestation and removing jarrah susceptible to leafminer infestation. • Monitored occurrence of Gumleaf Skeletonizer throughout Central and Southern forest region and demonstrated an increase in the population size of Gumleaf skeletonizer in January 1993. *Fire* • Collaborated with CSIRO Division of Forestry in a study of nutrient dynamics following prescribed burning of thinning slash in a karri regrowth stand. • Conducted five experimental burns in jarrah forests near Manjimup as part of a long term study to investigate the effects of different fire regimes on the jarrah forest understorey. • Documented the regeneration response of 187 jarrah forest plant species to fire and incorporated in a fire response data base. • Recorded and databased the age to first flowering after fire and month of peak flowering of 255 jarrah forest species. *Disease* • Developed a database of site and flora characteristics of over 300 sites infested with *P. cinnamomi* in the Northern Jarrah Forest, as a

OBJECTIVES	ACHIEVEMENTS
	basis for testing the theory that plant indicators can be identified and used to predict *P. cinnamomi* hazard. • Developed and tested two hazard prediction methods from the database, and commenced re-analysis of database with the aim of describing associations between site and flora characteristics and impact of *P. cinnamomi* and an indication of possible changes to existing hazard prediction systems.

SCIENCE PROJECTS: NATURAL PRODUCTS SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Abbott I	93/96	Control of Jarrah leafminer (JLM): (1) Performance and reinfestation of JLM in ground coppice after crown scorch by a moderate intensity prescribed spring burn. (2) Performance and reinfestation of JLM in ground coppice after crown scorch by an autumn prescribed burn.	Reduced density of JLM following scorching of jarrah crowns at forest block scale.
Abbott I	93/97	Control of Jarrah leafminer (JLM): Selective retention of JLM resistant trees and ground coppice in a demonstration forest plot	Demonstration that culling of jarrah susceptible to JLM results in more productive jarrah stands.
Brennan G	93/116	Effect of end treatment on CCA preservative penetration in regrowth karri transmission poles	Improved service life of karri poles.
Brennan G	93/117	Stability of 30 mm regrowth jarrah VALWOOD® coated with different exterior finishes when exposed to outdoor conditions	Increased marketability of jarrah VALWOOD® panels in outdoor uses (eg. cross-arms, posts, signboards).
Brennan G	93/118	Relationship between branch size, success of occlusion and branch angle to recovery for regrowth karri grown under wide spacing	Improved utilization of karri regrowth.
Brennan G	93/156	Assessing a solution of NP1 antisapstain control and borax for preventing sapstain and *Lyctus* spp. attack in Tasmanian bluegum Valwood boards	Reduced sapstain and *Lyctus* attack in VALWOOD® boards made from *Eucalyptus globulus*.
Brennan G	93/161	Effect of wood boring insects, brownwood, decay and tree growth patterns on wood quality in regrowth Karri	Improved understanding of impact of rot, borers and occluded branches on utilization of regrowth karri.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Brennan G	95/4	Assessing the long term efficacy of five different timber preservatives, used to treat hardwood and softwood fence posts and installed at different geographic locations	Most suitable preservative and treatment method for thinnings from regrowth marri stands on private property.
Burrows N	93/98	Effects of fire and logging on mortality, regeneration, floristic composition and structure of jarrah forest vegetation	Development of prescriptions to minimize any deleterious impact of timber harvesting on plant species and vegetation in jarrah forest.
Burrows N	93/99	Fire regime effects on the structure and floristics of jarrah forests	Improved understanding of long term consequences of prescribed burning in jarrah forest.
Burrows N	93/100	Wind speed profiles for predicting fire danger and fire behaviour in south-west forests	More accurate ways of forecasting fire danger and fire behaviour in forests.
Crombie S	93/101	Preliminary survey of the effectiveness of *Banksia grandis* removal in reducing potential *Phytophthora cinnamomi* host material in the northern jarrah forest in the medium term	Evaluation of cost-effectiveness and ecological appropriateness of reducing abundance of *Banksia grandis* in jarrah forest.
Crombie S	93/102	Water relations and growth of Jarrah on high, moderate and low impact dieback (*Phytophthora cinnamomi)* sites	Assessment of the effect of non-lethal dieback on timber production.
Crombie S	95/1	Comparison of chemical and biological methods for the control of Armillaria in regrowth karri	Demonstration of how regrowth karri can be grown productively on infested sites by Armillaria.
Farr J	93/103	Quantitative population monitoring of gumleaf skeletonizer *Uraba lugens* and impact assessment on Jarrah crowns	Predictive population model for gumleaf skeletonizer in southern jarrah forest.
Farr J	93/104	Distribution of gumleaf skeletonizer in the central and southern forest regions	Cost-effective early warning system of outbreaks of gumleaf skeletonizer.
Farr J	93/105	The influence of pheromones in the mating behaviour of *Tryphocaria acanthocera* (Coleoptera: Cerambycidae)	Improved knowledge of oviposition behaviour of a significant pest in karri regrowth.
Farr J	93/154	Impact of wood boring insects on wood quality in regrowth Karri in relation to site quality	Improved understanding of role of site quality in exacerbating damage done to karri regrowth by wood boring insects.
Friend G	93/115	Effects of timber harvesting on small vertebrates in medium rainfall jarrah forest	Development of logging prescriptions which minimize impacts on small vertebrates in jarrah forest.
Friend G	93/155	The effects of logging and fire (edge effects, habitat trees) on birds of the jarrah forest	Development of logging prescriptions which minimize impacts on bird populations in jarrah forest.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Friend G	94/7	Effects of timber harvesting on terrestrial invertebrates in medium rainfall jarrah forest	Process-based empirical data on the impact of timber harvesting on terrestrial invertebrate communities in jarrah forest. Development of predictive models of the response patterns of invertebrates to logging.
Glossop B	94/1	Improvement of solar kiln drying from modelling	Improved solar kilns.
Glossop B	94/4	Determination of drying schedules for WA timbers using a batch kiln	Drying schedules for use by the public and sawmillers, allowing commencement of higher-value products or greater recovery of dried appearance product.
McCaw L	93/106	Increasing productivity of karri regrowth stands by thinning and fertilizing	Determination of optimal stand densities for increasing productivity of karri regrowth.
McCaw L	93/107	Espacement effects on the development and form of regrowth karri stands	Scientifically-based prescriptions for specifying optimal initial spacing of nursery-raised seedlings to achieve a range of management objectives for regenerated stands.
McCaw L	93/108	Prescribed burning of thinning slash in young karri stands	Protocols for safe burning of slash.
McCaw L	95/2	Establishment and growth of karri stands in relation to soil characteristics. Part 1. Measurement of soil characteristics	Development of a technique suitable for field measurement of surface compaction in karri forest soils; quantification of variability in key attributes of karri forest soils on a range of sites, and the ability to design sampling protocols capable of quantifying substantial differences due to site and treatment factors; comparison of soil attributes of unlogged forest with sites logged under varying seasonal conditions.
Morris K	93/109	The effects of timber harvesting and associated activities on medium sized mammals in the jarrah forest	Development of logging prescriptions which minimize impacts on medium-sized mammals in jarrah forest.
Shearer B	93/110	Use of phosphonate to determine the effect of *Phytophthora cinnamomi* infection on growth of *Eucalyptus marginata*	Limiting infection in jarrah trees in jarrah forest.
Shearer B	93/111	*Phytophthora cinnamomi* impact in the northern jarrah forest: A re-analysis	Predictive model of dieback impact based on site characteristics.
Siemon G	93/119	Durability of WA grown timber species	More efficient utilization based on improved knowledge of performance of WA timber in service.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Siemon G	93/120	Improved preservation of karri power poles	More efficient preservation using new chemical formulations should permit greater use of karri for power poles.
Siemon G	94/10	Wood properties and utilization of regrowth karri	Basic data on wood properties of the regrowth karri resource.
Siemon G	95/5	Wood properties and utilization of karri oak (*Allocasuarina decussata*)	Basic data on wood properties and economic potential of karri oak.
Stoneman G	93/94	Regeneration of jarrah (*Eucalyptus marginata*) in the southern jarrah forest	Improved cost-effectiveness of regeneration operations in southern jarrah forest.
Stoneman G	93/95	Characteristics of hollow-bearing jarrah (*Eucalyptus marginata*) and marri (*Eucalyptus calophylla*) trees and coarse woody debris, their use by selected species of fauna, and the effect of logging and burning jarrah forest on them.	More effective selection and retention of hollow bearing habitat trees during logging operation in jarrah forest.
Stukely M	93/112	Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*	50 unrelated lines of jarrah resistant to *P. cinnamomi* from each of the 3 forest region.
Ward D	93/20	A method of assessing the distribution and abundance of brown boronia (*Boronia megastigma* Nees)	Cost-effective means of quantifying the Boronia resource.
Ward D	93/113	Primary damage caused by various methods of harvesting sprigs of brown boronia (*Boronia megastigma* Nees)	Guidelines for licensed pickers on the best methods of picking in order to protect the Boronia resource.
Ward D	93/114	Development of a fire technique for germinating Brown Boronia (*Boronia megastigma* Nees) seed in its natural habitat	Protocol for optimal regeneration of Boronia.
Wardell-Johnson G	94/8	Effects of timber harvesting on birds of the karri forest	Quantitative data on the short and long term impact of timber harvesting on bird communities in karri forest.

FUTURE DIRECTIONS

Research in native forests will concentrate on improving the utilization of native hardwoods by

i) improved seasoning and preservation techniques

ii) investigating timber defect and loss of production caused by various insect pests and

iii) continuing to develop ecologically sustainable silvicultural systems which meet the needs of timber production and of conservation. An important multi-disciplinary research project was initiated in 1994 to investigate the impacts of various silvicultural systems on wood production and on the jarrah forest ecosystem. This research aims to refine existing silvicultural systems and management practices to ensure that ecosystem processes and biodiversity are maintained in forests from which timber is harvested.

Research to develop appropriate management practices and ecologically sustainable harvest levels of commercially important wildlife such as Brown Boronia (*Boronia megastigma*) and other wildflowers will continue. The potential for sustainable commercial utilization of plants and animals that are presently not used will be explored.

Ongoing research into the establishment and growth of strains of jarrah which are resistant to the fungal pathogen *Phytophthora cinnamomi* will continue.

It is anticipated that involvement in bioprospecting (drug discovery programs) will increase in the next few years.

Achievements of the Tree Crops Section

Tree Crops Section is committed to understanding how tree crops can be used to optimise economic benefits and environmental benefits in land management.

Dr John McGrath
Section Manager

OBJECTIVES	ACHIEVEMENTS
To develop tree crops as integral, multiple purpose components of sustainable land management systems in the diverse environments found in southern WA	• Selected and assessed 3 sites for the establishment of demonstrations of pine integrated with farming (Dandaragan, Busselton and Boyup Brook) under the West Coast Pine Timberbelt Project. • Carried out whole-farm planning for each of the farm forestry sites, by integrating information on soils, geophysics, farm resources, landscape values and economics, to determine the optimum placement of pine. • Undertook surveys to define the areal extent of ringneck parrot damage in bluegums. Commenced evaluation of the seasonal pattern of damage in the worst affected zone (Boyup Brook to Darkan) and set up sites to test damage control techniques. • Modified bluegum planting designs to minimize the emerging problems of salt damage in low landscape plantings and drought death in the Boyup Brook to Darkan region. • Developed spreadsheet on likely returns for farmers undertaking softwood sharefarming with CALM using a cost recovery for CALM approach (ie no annuities). • Obtained $350 000 of external funding to allow extension of soil survey and land evaluation system to *E. globulus* planted on farms for land conservation purposes. • Participated in land evaluation and subsequent planning of Esperance Trees on Farms Project.
To provide the scientific information necessary to optimize production, and maximize on-site and off-site environmental benefits from all tree crop plantings.	*Pinaster pine tree breeding* • Collected pollen from the best breeding value second generation parents in the Hopkins Road clonal archive, as a basis for control crossing to develop an elite third generation population of pinaster pine. • Continued field checks and validation of plus trees with breeding trials in the Gnangara plantation. Best trees were grafted at Wanneroo in December 1993. • Carried out coning initiation studies at Manjimup orchard in 1992 - 1993 to evaluate fecundity of each parent used in the orchard. This information was used to calculate the overall breeding value of the

Manjimup orchard seed and provide estimates of future seed yields.

- Continued review of three decades of silvicultural research, particularly data relating to management regimes for stand density and thinning and fertilizer response.
- Carried out a large control pollination program in July/August 1993 for the Southern Tree Breeders' Association (STBA) to produce the genotypes for the next generation nucleus and main breeding populations. Collected pollen in August 1993 from the best ranked breeding value trees in the Hedged Artificially Pollinated Seed Orchard (HAPSO) for control crossing in 1994.

Radiata pine tree breeding

- Initiated cytoplasmic inheritance study in *P. radiata* in 1993. Information from this study will provide the guidelines for structuring of the STBA and CALM breeding populations and deployment of clones in HAPSO.
- Clear-felled the western two thirds portion of the WMSO in 1992 and prepared for planting as HAPSO unit 5. Planted 1185 grafts in HAPSO unit 5 and 219 grafts to complete the establishment of HAPSO Unit 4 in June 1993.
- Made 1981 grafts of the highest ranked *P. radiata* breeding value trees in the WA program for growth and tree form and *Phytophthora* resistance in September 1993. Graft survival in April 1994 was 86%.
- Carried out two emasculation studies in the HAPSO in 1993 aimed at fine tuning both the concentration and application of the maleic hydrazide growth retarding chemical.
- Carried out a series of gibberellin studies in the HAPSO in collaboration with other STBA members, resulting in 40% increase in cone production.
- Sowed control cross seed to generate new stock for cutting donor beds at Manjimup.
- Pollinated HAPSO units. The calculated breeding value of this pollen mix was 20.6% gain in volume, 16.5% gain in stem form, 17.1% gain in branch quality and 0.32 standard deviation gain in Pc. disease resistance.

Bluegum tree breeding

- Assessed the last of the CSIRO *E. globulus* collection trials planted in 1990 in January 1993. Best breeding value trees were selected and grafted for inclusion into seed orchards.

OBJECTIVES	ACHIEVEMENTS
	• Sowed *E. globulus* seed at Manjimup for 1994 planting of yield trials at Esperance, Albany, Collie and Busselton. (Yield trials are used to measure the actual gains achieved from tree breeding and to monitor progress of the program). • Grafted 75 new selections from CALM breeding population trials at Manjimup in October 1993. Achieved 72% success with the 2180 grafts. • Planted small *E. globulus* Open-Pollinated Seedling Seed Orchards (OPSSO) in 1993 on sites at Collie, Gnangara and Hope Valley. 64 of the best *E. globulus* families were sown at Manjimup for 1994 OPSSO planting at Albany and Collie. • Investigated the optimization of *in vitro* multiplication of *E. globulus* and showed that growth rate increased up to three weeks and thereafter declined. • Established a trial together with Bunnings Treefarms in 1993 investigating the difference between Micropropagation, cuttings and seedlings of *E. globulus*. • Showed that organogenesis from *E. globulus* leaf material was possible. • Gained RIRDC funding for three years to investigate the difference between micropropagation, rooted cuttings and seedling growth of *E. globulus* both in production and growth. The project is in the first year raising the material for trials. • Established a rooted cutting nursery at Como to screen 10 000 selected individual seedlings for their rooting ability. This process will continue for three years with field trials of the cuttings and the parent seedlings established for further clonal selection. • Investigated the effect of paclobutrazol on the flowering of *E. globulus* trees. Application either by injection or drench gave a significant response in 14 year old trees. Paclobutrazol stimulated flowering of two year old *E. globulus* seedlings. Investigated clonal response of *E. globulus* to paclobutrazol and showed that response was specific to clone. Incorporated the paclobutrazol treatment into management of OPSSO and clonal orchards for the Western Bluegum program and thinned the OPSSOs for improved seed production. • Investigated and improved the grafting success of *E. globulus* from 20% to 80% for the Western Bluegum project. Initiated the serial grafting process for *E. globulus* and modified the Wanneroo nursery to accommodate the system for the Western Bluegum project. In four months a third of the required grafts have been produced which completes the first clonal orchard of 5.5 hectares.

OBJECTIVES	ACHIEVEMENTS

- Monitored flowering times of clones for the future design of orchards and controlled pollination requirements.
- Investigated and devised methods for collecting, checking viability and storing *E. globulus* pollen. As the clonal orchard will be supplementary pollinated from 1994/95 to increase out-crossing, a large supply of pollen has been collected.
- Established an accelerated orchard at Como, which at present only has *E. globulus* grafts but will incorporate the oil mallees, *Phytophthora* -resistant jarrah and drought-tolerant *E. camaldulensis.*
- Collected the first improved *E. globulus* seed for the production of Western Bluegum seedlings.
- Expanded the Wanneroo serial grafting program, which involved major replacement and upgrading of existing nursery facilities. This is the first major investment in these facilities at Wanneroo since the early 1960s.
- Provided preliminary estimates of heritability of wood density in *E. globulus.*

Entomology

- Completed a two year trial of simulated herbivory on young *Eucalyptus globulus* and demonstrated that moderate and severe defoliations have severe short term effects. Longer term effects on growth were shown to depend on season and amount of damage.
- Developed and tested a chemical knockdown technique for sampling arthropod fauna in crowns of young *E. globulus.*
- Initiated a trial to investigate seasonal and tree growth effects on the structure and size of arthropod populations (including defoliating insects) in young *E. globulus.*

Mycology

- Achieved syntheses between sterile *Pinus radiata* seedlings and other species of mycorrhizal fungi not previously used in WA.
- Provided advice on health problems of pines and bluegums to growers of tree crops throughout the State.
- Assessed tolerance of *P. radiata* waterlogging in a glasshouse experiment.

OBJECTIVES	ACHIEVEMENTS
	Agroforestry and silviculture • Collected and summarized data on chipwood yield at first commercial thinning from five and six row belts of *P. radiata*. • Collected and summarized data (height and DBHOB) of 4 and 6 year old eucalypts growing at wide spacing on 3 sites for high quality sawlogs. • Commenced testing Victorian FARMTREE model with Peter Eckersley (DAWA Bunbury) using pine timberbelt data. The model incorporates data such as tree growth rates, response to tree spacing and shelter effects on crops and livestock and predicts profitability of different tree growing options. • Established permanent measurement plots (4 per site) in each of the 24 bluegum trial plots established in the Esperance region and assessed survival height and DBHOB (of trees 3 years or older). • Formulated strategy to increase the growth rates of existing pine plantations using information from long term fertilizer trials in *P. radiata* plantations. • Set-up five new trials consisting of 200 plots to examine the response of *E. globulus* to nitrogen, phosphorus and potassium. • Established a nitrogen by phosphorus response trial in thinned *P. radiata* plantation on the Donnybrook Sunkland to determine the optimum fertilizer application in these plantations. • Established two trials to examine the interaction between thinning and fertilization in pinaster and radiata plantations on the Coastal Plain at Harvey. • Introduced heat pulse sap flow metering technology for more accurate monitoring of water use by pines in plantations. • Measured and maintained a series of trials (on 16 sites) ranging from Albany to Harvey, examining the response to fertilizer in pine and eucalypt plantations (532 plots and approx. 16000 trees are assessed annually, additionally 4 of the sites are assessed each month and 6 sites are assessed quarterly). • Designed new soil and land evaluation system for *P. radiata* sharefarms based on best available practice (ie. USDA, FAO). • Demonstrated land evaluation techniques on farming property at Mt Barker.
To evaluate and initiate the development of new tree crop species, products, industries and markets.	• Established trial plots of Tasmanian bluegum on 24 sites in the Esperance region, mostly in 1992 and 1993. • Carried out tending (culling and pruning) of wide spaced eucalypts for high quality sawlogs on study

OBJECTIVES	ACHIEVEMENTS
	sites at Busselton, Middlesex and Dinninup. • Established species trials of 9 species or subspecies of oil eucalypts at 22 locations across the wheatbelt. • Published paper on genetic variation in Karri and potential gains from selection. • Established genotype and environment interaction trials of *E. globulus* at Esperance. • Completed main-range Marri seed collection ready for trial establishment. • Established two oil eucalypt trials in Wellington catchment. • Measured and analysed year 1 acacia seedlings and family provenance trials. • Completed measurement of *E. botryoides* trials at Busselton and Worsley minesite Boddington. • Established *E. nitens* seed orchard at old Nannup Nursery. • Measured *E. sideroxylon* trial at Wellington catchment (sister trial at Arthur River to be measured if time and resources permit). • Completed first measurement of Highbury sandalwood host trial. • Designed and initiated new sandalwood host trial near Woodanilling. • Initiated a successful oil mallee (*E. kochii* spp *kochii, E kochii* spp *plenissima, E. horistes and E. polybractea)* grafting program to accelerate the breeding program and establish clonal orchards. • Commenced genetic improvement programs on two species of oil mallees capable of development as multiple purpose tree crops for the wheatbelt. • Established 5 species trials and two family trials of *Acacia mearnsii* in 1992 and 1993 to explore the possibility of growing the bipinnate acacias as a commercial timber source in Western Australia. • Established demonstration and commercial development plantings of oil mallees over 250 ha in P93 and 1250 ha in P94 concentrated into six centres ie. Esperance, Woodanilling , Lake Toolibin, Narembeen, Kalannie, Canna.
To provide support for other programs within CALM (eg physical resource information, materials analysis) to aid planning and management in parks, forests and plantations.	• Provided identifications of arboreal insect pests and advice on control measures in response to requests from CALM district and regional offices. • Established physical resource survey team and trained two Technical Officers to undertake soil and site evaluations.

OBJECTIVES	ACHIEVEMENTS
	• Set the guidelines for contractors to undertake soil and site surveys. • Characterized farms for *P. radiata* sharefarming and characterized trial plots. • Carried out a range of routine physical and chemical analyses in the CALM Como laboratories to support programs not only in the Tree Crop Section, but elsewhere in CALM.

SCIENCE PROJECTS: TREE CROPS SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Abbott I	93/153	Control of insect pests in young plantations of *Eucalyptus globulus*: Early indicators of pest insect outbreaks and the beneficial impact of spiders and parasitoids	Cost-effective and scientifically sound sampling strategy; demonstration of the abundance of insects, both beneficial and potential pests, in bluegum crowns; advice to plantation management on the risk of insect outbreaks during the current rotation.
Barbour L	93/131	Assessing the wood quality of *Eucalyptus globulus* breeding selections	Identification of a sampling system that can be used to collect wood samples to assess wood density and pulp yield, and provision of wood density and pulp yield data for the breeding program.
Barbour L	93/132	Improving seedling nursery techniques: Drilling of pre-germinated seed	Identification of optimal conditions for seed germination.
Barbour L	93/133	Testing bipinnate acacias for a tree crop in Western Australia	Identification of species of commercial value to WA in terms of survival and growth.
Barbour L	93/134	Orchard management for the supply of superior *Eucalyptus globulus* seed	Improved grafting techniques and optimized paclobutrazol applications for increased seed production.
Barbour L	93/135	Preparing for the clonal option for the selection and propagation of oil mallees	Advice on the merits of clonal vs family breeding.
Barbour L	93/136	The development of vegetative multiplication techniques for *Eucalyptus globulus* clonal forestry	Identification of the most promising techniques to pursue for clonal forestry and provision of vegetatively-multiplanned material of the top breeding families.
Bartle J	93/84	Effect of parrot population control on damage to bluegum	Development of practical methods of controlling twenty-eight parrots.
Bartle J	93/164	Seasonal variation in parrot damage to bluegums	Protocol for determining when control is warranted.

Name	SPP No	Title (Abridged)	Anticipated Outcome
Bartle J	94/12	Silvicultural treatment of parrot damage to bluegums	Silvicultural treatments (eg suitable for pruning, culling and coppicing), represent an approach to managing parrot damage by rectifying the damage after it has occurred.
Butcher T	93/146	*Pinus pinaster* tree breeding - strategy and breeding population development	Formulation of a low cost future breeding strategy and development of new and improved seed orchards of *P. pinaster* at Nannup.
Butcher T	93/147	*Eucalyptus globulus* tree breeding - strategy and breeding population development	Identification of superior trees for breeding.
Butcher T	93/148	*Pinus radiata* tree breeding - strategy and breeding population development	Increased productivity of plantations.
Crombie S	93/152	Measuring transpiration in *Pinus* spp. using the heat pulse velocity (HPV) technique	Improved stand management in avoiding competition between trees for water or mortality from drought, and maximizing tree productivity and ground water use.
Davison E	93/124	Inoculation of *Pinus radiata* seedlings with different mycorrhizal fungi	Improved establishment and initial growth of *P. radiata* on farmland.
Harper R	93/123	Performance of *Eucalyptus globulus*, planted on farms, in relation to soil and site attributes	Improved ability to predict performance of trees prior to establishment and to minimize economic failures.
Harper R	93/130	Determining the cause of death of *Eucalyptus globulus* grown on shallow soils on the Darling Plateau	Identification of critical edaphic factors so as to enhance tree performance.
Harper R	93/151	Site specific silviculture: making management decisions for *Pinus radiata* plantations on the basis of a site's water relations	Optimized silvicultural requirements on a site-specific basis, and provision of a framework for vetting silvicultural research priorities within second growth plantations.
Harper R	93/158	Physical resource assessment team	Prediction of silvicultural requirements (ripping, mounding, fertilization) for specific sites before trees are planted.
Mazanec R	93/126	Genetic variation in quantitative trials of exotic and endemic plantation and rehabilitation species	Detailed knowledge of the performance of tree species with commercial potential or for use in rehabilitation of farmland.
Mazanec R	93/129	Karri inbreeding/ outcrossing studies	Understanding of the prevalence of inbreeding in Karri.
Mazanec R	93/150	1. *E. calophylla* family provenance trial. 2. Kino-free marri trials	Detailed knowledge of genetic variation in marri (a tree species with the potential to produce sawlogs and pulp).

Name	SPP No	Title (Abridged)	Anticipated Outcome
Mazanec R	94/2	Sandalwood host trial - Katanning district	Information on: establishment densities of S. *spicatum* required to produce a crop; suitability of 5 host species, each of which has market potential as a specialty timber; relative growth of each host/parasite combination.
McGrath J	93/121	Early rotation nutrition of *Pinus radiata* on ex-pasture land on the south coast of WA	Increased wood production, resulting in greater economic return on plantation investment.
McGrath J	93/122	Diagnosis of nutrient deficiencies in young *Pinus radiata* using foliar analysis	Increased wood production, resulting in greater economic return on plantation investment.
McGrath J	93/128	Early-mid rotation nutrition of *Eucalyptus globulus* in south-west WA	Accurate fertilizer recommendations for plantations, maximizing production and economic return while minimizing potential eutrophication of water bodies by targeting areas that require fertilization.
McGrath J	93/140	Mid rotation responses to thinning and fertilization by *Pinus radiata*	Increased wood production, resulting in greater economic return on plantation investment.
Moore R	93/125	Oil eucalypts as a multi-purpose tree crop for the Wheatbelt	Commercial tree crop to assist in revegetation of 10-20% of Wheatbelt.
Moore R	93/127	West Coast pine timberbelt project	Commercial tree crop to assist in revegetation of 10-20% of degraded land.
Moore R	93/137	Pine timberbelts	Demonstration of on-and off-farm benefits to landowners of integrated timberbelts.
Moore R	93/138	Eucalypts for high quality sawlogs, integrated with farming	Demonstration of significant commercial value of hardwoods in >450 mm annual rainfall zone.
Moore R	93/139	*Eucalyptus globulus* as a multi-purpose tree crop on the Esperance sandplain	Demonstration that bluegum plantations are commercially viable on the Esperance sandplain.

FUTURE DIRECTIONS

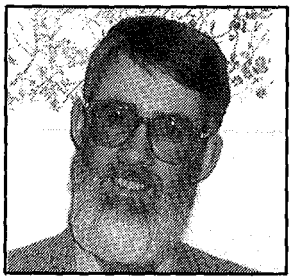
The rapid expansion of the bluegum plantation pulpwood industry in WA will result in an increase in the diversity of sites on which plantations are established. The majority of bluegum plantations will be planted on farmland. These developments will change the emphasis within the Tree Crops Section (formerly the Plantation Silviculture Program) from pine plantations to eucalypt plantations. Major areas that will require research will be tree selection and breeding, site selection, silvicultural management and pest control. The integration of trees into agricultural systems so that the economic and environmental benefits of tree crops are maximised also presents a major challenge.

The Oil Mallee Eucalypt Program will also increase in importance in future years, and will require research support in tree breeding, insect and disease control, and silviculture.

There will be a continuing requirement for information to increase the productivity of the pine plantations. In particular the improvements that can be gained by using improved genetic material and the gains in production following fertilization will be important to ensure that the plantations are economically viable.

Achievements of the Science Services Group

Science Services Group is committed to delivering key corporate services to Science and Information Division.



Dr Ian Abbott
Head of Group

OBJECTIVE	ACHIEVEMENTS
To ensure that essential financial, computing, biometrical, publishing and vegetation health services are provided to support the Mission of Science and Information Division.	• Re-organized accounting system to reflect the new structure of the Science and Information Division. • Setup user-friendly presentation of Oracle financial information for all SID staff. • Checked all Science Project Plans for valid research design and statistical methodology. • Completed computer networking within and between major Research Centres. • Published 4 issues of *Nuytsia* and 8 issues of CALM's new science journal *CALMScience*. • Established a technologically advanced germplasm storage for plant species susceptible to dieback disease.
Re-organize the existing Dieback Disease Detection Service and Plantation Health Service into a more integrated Vegetation Health Service, and formulate the objectives, strategies and outcomes of this Service.	• Integrated existing disease services into a Vegetation Health Service. • Data-based all of CALM's records of *Phytophthora*-caused disease. • Produced preliminary maps of the known occurrence of 4 species of *Phytophthora*.

Achievements of the Information Science Section

Information Science Section is committed to the development of corporate computer-based databases and the provision of effective means of retrieval and exchange of information.

Nicholas Lander
Section Manager

OBJECTIVES	ACHIEVEMENTS
To provide an integrated environment for capture, processing, analysis and dissemination of information at Centre, Divisional and Departmental levels.	• Completed installation of Local Area Network (LANs) at all major Research Centres. • Continued to develop strategies for making corporate data available to staff (eg. Corporate Data Dictionary). • Continued the acquisition of strategic geographic data sets for Divisional use in GIS analysis. • Set up communications outside CALM (eg. Internet). Developed expertise and provided training in initial access to Internet. • Developed and tested strategy for online access to corporate information on the VAX using current PC softwares. • Implemented two systems using the online access strategy developed. • Maintained and developed expertise in the most up-to-date information management tools and techniques.
To raise and maintain standards of research, planning and analysis and to ensure efficient data collection and management.	• Helped staff in using specialized software packages (eg. Stats, mapping), designing systems, and interrogating data. • Helped staff developed skills in information technology and information management methodology. • Prepared additional components to SPP proforma ensuring appropriate data management by staff.
To collaborate with scientists on research projects requiring a high level of analytical sophistication.	• Developed a front end to integrate the Herbarium's Descriptive Catalogue database with the DELTA system (from CSIRO). • Upgraded the specialist HERBIE system. • Continued upgrading and improvement of the WACENSUS database and associated protocols. • Started significant work on investigating the use of grid based analysis in modelling dieback spread. • Collaborated with scientists, resulting in co-authorships of a number of papers.

OBJECTIVES	ACHIEVEMENTS
To increase computer literacy and expertise amongst research staff and to introduce them to new products so they can benefit from new technology.	• Conducted a number of training courses and workshops throughout the Division. SID staff are now using sophisticated tools and techniques for analysis and presentation. • Introduced staff to Time Series Analysis (TSA) techniques.
To communicate and integrate with other groups within CALM and appropriate external organisations to allow for exchange of research findings, ideas, data, software and other products.	• Prepared SPPs jointly with other Groups within SID (eg. DELTA-Paradox interface, "Descriptive taxonomic databases" project, the ANCA-funded *Phytophthora* project). • Developed significant cooperation with Information Management Branch (IMB) in managing geographic data and other forms of mutual assistance. • Collaborated with Information Management Branch to develop the LAN and WAN for Manjimup (Research, Region, District and Forest management) • Collaborated with Information Management Branch to take over responsibility for the Crawley LAN. • Collaborated with Information Management Branch to plan and implement other Internet connections. • Collaborated with ERIN (Environmental Resources Information Network) regarding setup and training of their provided Internet connection. • Provided expert consultation services to internal and external agencies both locally and interstate (eg. Kings Park, Queensland Herbarium).

SCIENCE PROJECTS: INFORMATION SCIENCE SECTION

Name	SPP No	Title (Abridged)	Anticipated Outcome
Gioia P	93/51	SID Corporate data register	Register of data available corporately with CALM : increased access and reduced duplication.
Yung M	93/50	Evaluation of time series analysis techniques	Detection of cycles in rainfall, an important factor in tree growth and possibly in the development of insect outbreaks in forest.

Note: Information Science staff are actively involved in SPPs in the three Science Groups

FUTURE DIRECTIONS

Information Science Section will be actively involved in five broad areas: Research and Development, Information and Systems, Infrastructure, Service and Support, and Training. In Research and Development there will be collaboration with scientists to develop sophisticated processing methods and techniques and to develop specialized systems; development of methodology and mechanism for utilizing new technology especially in sharing data across geographical locations and at the same time preserving local intelligence; implementation of intelligent systems and development of interfaces to them (eg interface to the DELTA system); and research into the underlying principles and concepts behind current information technological developments.

Information and systems will entail provision of access to corporate information across all centres in SID; identification of key corporate data and development of an automated corporate data directory; identification of key areas and systems; prioritization, development and implementation; integration of existing and new datasets to develop key information systems; and integration of existing and new systems into an integrated environment across SID.

Infrastructure will be mainly concerned with network communications and will involve: maintenance of LAN connectivity at the major centres (in collaboration with Information Management Branch to install and maintain LANs for the remaining SID centres); provision of enhanced WAN connectivity to all SID centres; provision of expertise to enable SID staff to access INTERNET. Communications between platforms relates to the provision of seamless communications across hardware and software platforms.

Service and support involves the provision of ongoing essential service and support to SID staff. Training is concerned with providing specialized training to staff to raise and maintain standards of research, planning and analysis and to ensure efficient data management and management.

Achievements of Biometrical Services

OBJECTIVES	ACHIEVEMENTS
To raise and maintain standards of research planning and analyses.	• Completed a planning study of trends in the use of statistical methods in CALM's primary fields of study, with recommendations for future resourcing. • Completed a study of the application of statistical methods in published papers within the Division, with recommendations for an improved system. • Collaborated on 5 major and a number of minor science projects, resulting in co-authorship of a number of scientific papers and reports. • Applied a novel method of analysing impact studies to data from the Stirling Range National Park, and presented this at an international conference. • Developed a new method for analysis of species-area data. • Developed improvements to the method of detecting competitive displacement.
To ensure efficient experimental design.	• Assessed the proposed statistical methods in over 100 science project plans. • Provided *ad hoc* advice on experimental design and analysis to scientists within all areas of SID, and to others external to the Division.

FUTURE DIRECTIONS

Collaboration with SID scientists on research projects requiring a high degree of biometrical expertise will expand.

Achievements of Financial Services

OBJECTIVES	ACHIEVEMENTS
To design and maintain Revenue and Account Structures which are effective and efficient.	• Completed basic design and restructure of accounts to match restructure of Science and Information Division.
To provide regular financial reports within five days of an accounting period and as required on request.	• Achieved provision of financial reports within time frames required.
To match expenditure within set budgetary targets for SID within CALM.	• Monitored expenditure to budgetary targets set.
To authorize and process accounts within three days of receipt.	• Processed accounts within the specified periods.

FUTURE DIRECTIONS

Financial control over grants from external funding organizations will be streamlined.

Achievements of Science Publications

OBJECTIVES	ACHIEVEMENTS
To increase awareness of CALM scientific research and technical investigations by publishing and disseminating that work in a clearly identifiable CALM journal.	• Published *CALMScience*: Vol. 1 No. 1 (106 pp) Vol. 1 No. 2 (137 pp) Vol. 1 No. 3 (118 pp) Vol. 1 No. 4 (151 pp) + Index to Vol. 1 • Published *CALMScience* Supplement: 1 (136 pp) 2 (206 pp) 3 (258 pp) 4 (225 pp) + Index to Supps. 1 - 4. • Published: 2 Technical Reports 1 Research Bulletin 1 Occasional Paper 2 Wildlife Management Programs 6 WURC Reports. • Published *Nuytsia*: Vol. 8 No. 3 (173 pp) + Index to Vol. 8 Vol. 9 No. 1 (135 pp) Vol. 9 No. 2 (169 pp) Vol. 9 No. 3 (133 pp) + Index to Vol. 9. Vol. 10 No. 1 (142 pp) • Organized *CALMScience* editorial meetings, prepared agendas and distributed minutes. • Formulated *CALMScience* editorial policy and guidelines. • Received 19 new manuscripts (1180 pp).
To enhance the status of CALM's scientific research and technical investigations by publishing and disseminating that work in a manner commensurate with international journal standards and principles.	• Organized and co-ordinated scientific refereeing for manuscripts submitted. • Edited submitted manuscripts according to international principles and conventions of scientific publishing.
To publish and disseminate papers reporting CALM's scientific research and technical investigations in a cost-effective and market-oriented manner.	• Drafted internal and library exchange distribution list for *CALMScience*. • Upgraded computer skills.

FUTURE DIRECTIONS

A Science Publications Unit has been formed to work on SID publications, bringing together the editing and layout functions of *Nuytsia* and its new sister journal, *CALMScience*. The Unit is part of the Corporate Relations Division, reporting to Dr Ray Bailey (Manager, Programs and Publications). Staff consist of Kevin Kenneally (Co-ordinator), Marianne Lewis (Editor), and Wendy Searle (Assistant Editor). They are based in Como and will work with SID staff to bring out a minimum of two issues of each journal per year.

Achievements of Threatened Flora Seed Centre

OBJECTIVES	ACHIEVEMENTS
To develop a comprehensive seed based germplasm collection for rare and threatened plant taxa in Western Australia with the initial aim of capturing 75-80% of all genetic variation within each taxon.	• Acquired or collected 160 accessions of largely *Phytophthora* susceptible rare and threatened Western Australian plants from 68 taxa in 17 genera.
To utilize appropriate protocols for the medium and long term storage of seed from rare and threatened plant taxa in Western Australia and maintain an integrated database on seed provenance and seed biology for each taxon.	• Developed and applied appropriate protocols for the medium and long term storage of the above species. • Instigated seed germination and dormancy breaking trials for a representative portion of all accessions in the Threatened Flora Seed Centre. • Developed databases for the listing of all information concerning seed provenance, germination, moisture content and storage. Developed an additional database for phenological information pertaining to Western Australian rare and threatened flora.

FUTURE DIRECTIONS

Listings of *Phytophthora* and canker susceptible rare and threatened taxa will continue to be updated as information becomes available. Where feasible the Threatened Flora Seed Centre expects to capture and maintain, in medium and long term storage, seed germplasm covering 80-90% of the genetic resources of all rare and threatened susceptible taxa in Western Australia.

Achievements of Vegetation Health Service

OBJECTIVE	ACHIEVEMENTS
To help maintain and protect the State's vegetation resource by providing accurate diagnosis of the cause of plant disorders and advice on cost-effective remedial measures.	• Established in August 1993 the Vegetation Health Service (VHS) by combining the Dieback Disease Detection Service (DDDS) and the Plantation Health Service (PHS). • Processed soil and plant material to detect and identify the presence of *Phytophthora* species in CALM's estate as part of its hygiene operations. • Diagnosed plant disorders and made recommendations to minimize losses or to avoid further recurrences of problems within CALM's plantations and plant nurseries. • Integrated the *Phytophthora* diseases detection work (DDDS) and the other plant disorders handled by the former PHS. Since July 1992, 3169 samples were processed from which 1111 samples gave positive recovery of a *Phytophthora* species, namely : *P. cinnamomi* = 905 *P. cryptogea* = 49 *P. megasperma* = 78 *P. nicotianae* = 3 *P. citricola* = 69 • Commenced a computerized data base of the host range and distribution of *Phytophthora* (9836 records). • Collected records of other plant disorders and commenced development of a computer data base (318 cases of various plant disorders). • Maintained a collection of living cultures (348) of plant pathogenic fungi, mainly *Phytophthora* species. • Reviewed diseases of *Eucalyptus globulus* in Western Australia and internationally; commenced preparation of a plant diseases manual.

FUTURE DIRECTIONS

The *Phytophthora* computerized data will be interpreted and then communicated to District and Regional staff via computer-generated distribution maps at various scales.

Current science projects

In this Section information is provided on the hypothesis being tested and progress to date. More detailed information of a technical nature is available from the scientist responsible for the Science Project Plan.

ABBOTT, IAN

SPP No: 93/21

Title: Invertebrate conservation in an urbanized landscape: The native earthworm fauna of the metropolitan sector of the Swan Coastal Plain and its representation in the conservation estate.

Hypothesis under test: Native species of earthworm are restricted to particular landform units and vegetation types, and are adequately conserved to the extent that these landform units and vegetation types have been protected from excessive disturbance.

Progress to date: 40 localities have been sampled, and about 20 to 30 earthworm species have been found. Many of the species are novel and some are known only from single collection sites, some without planned protection. The Swan River appears to form a provincial boundary with two common species found only north of the river and some species only from south of the river. The fauna south of the river appears more diverse but collected material is only roughly sorted to date.

SPP No: 93/96

Title: Control of Jarrah Leaf Miner (JLM): (1) Performance and reinfestation of JLM in ground coppice after crown scorch by a moderate intensity prescribed spring burn. (2) Performance and reinfestation of JLM in ground coppice after crown scorch by an autumn prescribed burn.

Hypothesis under test: Crown scorch of jarrah from prescribed moderate intensity fire, spring or autumn, at the scale of a forest block, reduces outbreaks of JLM for longer than one year.

Progress to date: The autumn fire was set in 1993 and 30 treatment and 30 control transects were installed in November 1993; the spring fire was set in November 1994 and extensive areas of complete crown scorch were achieved. About 2/3 of spring treatment transects were fortuitously assessed immediately prior to the fire to supplement pre-fire assessments from November 1993. Ten supplementary control plots were installed and assessed to replace controls consumed by the spring fire. All transects for spring and autumn fires were assessed in November 1994.

SPP No: 93/97

Title: Control of Jarrah Leaf Miner (JLM): Selective retention of JLM resistant trees and ground coppice in a demonstration forest plot

Hypothesis under test: Health and productivity of jarrah stands can be improved by removing jarrah susceptible to JLM.

Progress to date: 12% of jarrah stems (9% of stand basal area) were resistant to JLM prior to felling (completed summer 1993/4). Residual stems were reassessed in November 1994.

SPP No: 93/153

Title: Control of insect pests in young plantations of *Eucalyptus globulus*: Early indicators of pest insect outbreaks and the beneficial impact of spiders and parasitoids.

Hypothesis under test:
- Biomass and diversity of arthropods (especially pest groups) in canopies of young *E. globulus* vary seasonally.
- Biomass and diversity of arthropods increase as canopy biomass increases.

Progress to date: Preliminary conclusions based on partial data set: Biomass and diversity of pest groups are strongly seasonal and influenced by plant age. Pest biomass per unit plant biomass is greatest by the end of first spring. Arthropod diversity increases with plant age.

ALGAR, DAVID

SPP No: 93/46

Title: Relative acceptability of bait materials to feral cats

Hypothesis under test Baits differ in palatability and attractiveness to cats.

Progress to date: Five commercially available 1080 bait types were tested as a preferred bait choice. A number of additives that cause an ingestion response were also investigated to improve bait uptake. All these trials were conducted using non-toxic baits in pen trials.

Three bait types were selected from the range of responses achieved from the pen trials to assess feral cat bait preferences. The two most preferred bait types (*roo meat + digest* and *pussoff + digest*) were selected and foxoff as the least preferred as control bait. Field trials, although on a smaller sample size, ensured that the results obtained from pen trials, using urban cats, were not biased because of previous domestic feeding history.

This research has been completed and is currently being prepared for publication.

Manuscripts in draft: Relative acceptability of bait materials to cats.
A technique, using cafeteria trials, to assess feral cat bait preferences.

SPP No: 93/47

Title: Measuring the effectiveness of 1080 baiting to control feral cats

Hypothesis under test Bait of proven acceptability (see SPP No. 93/46) are more effective than the standard 1080 meat bait in killing feral cats in the field.

Progress to date: This research commenced in November 1994.

BARBOUR, LIZ

SPP No: 93/132

Title: Improving seedling nursery techniques: Drilling of pre-germinated seed

Hypothesis under test: Nil

Progress to date: Data have been collected on: identifying the optimum conditions for *E. globulus* seed germination; identifying inhibitory nutrient or fungicide effects on

germination and emergence; assessing whether the route of pre-germinating the seed prior to drilling can be pursued; the effect of dibbling depth on emergence and seeding quality.

SPP No: 93/133

Title: Testing bipinnate acacias for a tree crop in Western Australia

Hypothesis under test: Nil

Progress to date: Data have been collected on: identification of bipinnate acacia species of commercial value to Western Australia and their survival and growth under various conditions.

SPP No: 93/134

Title: Orchard management for the supply of superior *Eucalyptus globulus* seed

Hypothesis under test: Nil

Progress to date: Data have been collected relating to the following: improved grafting techniques for the capture of superior material; optimised graft and seedling fertigation for growth and seed production; optimised paclobutrazol applications for increased seed production; standardized pollen collection, storage and viability tests; methods for controlled pollination techniques; and the effect of other plant hormones on sex expression and flower initiation.

SPP No: 93/135

Title: Preparing for the clonal option for the selection and propagation of oil mallees

Hypothesis under test: Nil

Progress to date: This project will lay the foundation so that CALM can choose either the clonal route or family breeding route for the mallees.

SPP No: 93/136

Title: The development of vegetative multiplication techniques for *Eucalyptus globulus* clonal forestry

Hypothesis under test: Nil

Progress to date: This project is identifying the most promising technique(s) to pursue for clonal forestry; providing vegetatively multiplied material of the top breeding families; and providing the basis for a clonal program.

BARTLE, JOHN

SPP No: 93/84

Title: Effect of parrot population control on damage to bluegum

Hypothesis under test: Parrot damage to bluegum can be controlled by reducing parrot populations; this control can be achieved efficiently and humanely. Reductions in parrot populations might be effective in reducing damage. Even if population control is only local and temporary it may be focused during sensitive stages in growth of the bluegum crop for greater efficiency. Many possible techniques could be explored but trapping and shooting are most likely to be acceptable.

Progress to date:	No results yet

SPP No:	93/164
Title:	Seasonal variation in parrot damage to bluegum
Hypothesis under test:	Parrot damage to bluegum varies seasonally, between sites and between years
Progress to date:	A damage index (% trees attacked per day) has been developed. Damage peaks in summer with attack rates of 2.5% of trees/day, which is tenfold the winter rates. Attack appears to be greatly influenced by availability of other food sources eg a marked decline in attack rates in summer was observed to coincide with marri flowering.
Manuscripts in draft:	A comprehensive review 'Parrot damage to bluegum crops' has been completed and submitted as part of the requirements a project sponsored by the Commonwealth Vertebrate Pest Program. This work has been conducted by forestry consultant Peter Ritson and his review is available for circulation. The review forms the background of an application for funds for stage 2 of the project.

SPP No:	94/12
Title:	Silvicultural treatment of parrot damage to bluegum
Hypothesis under test:	Parrot damage to bluegum can be overcome by practical silvicultural treatments; Silvicultural techniques must be targeted to specific ages for efficient recover from damage. Pruning, culling and coppicing are techniques by which a damaged stem might be recovered or replaced. These techniques could be undertaken at a stage when the trees have the growth rate and size such that further damage is not likely
Progress to date:	No results yet

BATHGATE, JOCELYN

SPP No:	93/67
Title:	Control and management of stands of *Banksia coccinea* infected with *Diplodina* sp
Hypothesis under test:	Smaller intervals between burns reduce disease levels in *B. coccinea.*
Progress to date:	Surveys of disease levels in relation to fire history have been completed.

BELLGARD, STAN

SPP No:	93/79
Title:	The control and management of *Phytophthora megasperma* in the National Parks and Nature Reserves of WA
Hypothesis under test:	Nil
Progress to date:	Data on applied aspects of biology, ecology, and epidemiology of *P. megasperma* have been collected.

BRENNAN, GARY

SPP No: 93/116

Title: Effect of end treatment on CCA preservative penetration in regrowth karri transmission poles

Hypothesis under test: Problems had occurred with CCA treatment of karri poles because of tyloses forming in the sapwood soon after felling and docking, and preservative retentions were reduced. This experiment assessed the hypothesis that docking the poles to length immediately after the tree was felled, and then end-sealing the sapwood band with *Pabco* or *Cellavit WR151*, would result in reduced formation of tyloses which would be reflected by improved penetration and retention of CCA in the power pole. After treatment using a long-wet vacuum method, penetrations and retentions of CCA preservative into green and dry (sapwood below 30 percent moisture content) karri poles were compared.

Progress to date: Specimens taken from the well treated zone, apparently poorly treated zone and untreated heartwood are being regularly assessed for termite attack on the WURC stockpile. After 3 years and 10 months the samples in the well treated zone are performing best.

SPP No: 93/117

Title: Stability of 30mm regrowth jarrah VALWOOD® coated with different exterior finishes when exposed to outdoor conditions

Hypothesis under test: To protect glue laminated products from delaminating, a timber finish needs to be applied. In outdoor conditions, continuous wetting, drying and exposure to ultraviolet light are very severe on glue laminated products. There is a large market potential for VALWOOD® products in outdoor uses eg. SECWA pole cross arms, verandah posts and signboards. Finding a suitable timber finish will benefit producers and end users of VALWOOD®. The performance of three proprietary brands of resorcinol formaldehyde used to glue regrowth jarrah signboards and sealed with different paint systems was assessed.

Progress to date: At the completion of the trial wet cleavage tests will be done to determine glue strength.
Performance of 30 mm regrowth jarrah VALWOOD® signboards under exterior conditions. This report has been accepted by *CALMScience*.

SPP No: 93/118

Title: Relationship between branch size, success of occlusion and branch angle to recovery for regrowth karri grown under wide spacing

Hypothesis under test: The increasing importance of the regrowth karri forest resource makes it essential to assess the relationship between branch habits and the incidence of associated defective wood. These data are essential for planning harvesting and for efficient utilization. Three trees have been harvested from Eastern Break, Pemberton and all have been examined for external branch and stub dimensions. One tree has been cut horizontally into slabs and examined internally for knot and stub characteristics.

Progress to date: A summary of this work is included in a progress report on karri utilization research - February 1993. Ongoing research with Forest Management Branch and other SID staff will quantify these relationships.

SPP No: 93/156

Title: Assessing a solution of *NP-1* anti-sapstain control and Borax for preventing sapstain and *Lyctus* spp. attack in Tasmanian bluegum VALWOOD® boards

Hypothesis under test: This research will develop an effective method of preventing sapstain and *Lyctus* spp attack in Tasmanian bluegum VALWOOD® boards. Effective control will result in higher grade VALWOOD®, and would be applicable to other sizes.

No single chemical is available to control both fungal growth during dip-diffusion and *Lyctus* attack when the timber is in-service. Some anti-sapstain chemicals are compatible with boric acid and can be used in combination to prevent both sapstain and *Lyctus* attack. *HYLITE 711, HYLITE Extra* and *NP-1* are chemicals which are suitable fungicides for protecting timber during boron diffusion.

Progress to date: Treating at different concentrations of preservatives (*NP-1, HYLITE 711, NP -1* plus Borax and Hylite 711 plus Borax) did not prevent discoloration when stored under condition extremely favourable to fungal growth. Further trials will look at other chemicals (eg *HYLITE Extra*) in combination with Borax and test different storage conditions during diffusion.

Manuscripts in draft: Evaluating the combination of Borax and anti-sapstain chemicals in preventing sapstain and *Lyctus* spp. attack in Tasmanian bluegum VALWOOD® boards.

Two information sheets have been written for circulation within the timber industry.

- Treating *Lyctus* susceptible sapwood.
- Anti-sapstain treatment of logs and sawn timber.

SPP No: 93/161

Title: Effect of wood boring insects, brownwood, decay and tree growth patterns on wood quality in regrowth karri

Hypothesis under test: Wood boring insects, brownwood, incipient rot and occluded branches detract from wood quality and subsequent utilization.

Progress to date: Logs from a 30-year-old naturally regenerated karri stand from Nairn 9, Pemberton Districts have been delivered to WURC, cut into 25 mm slabs and assessed for internal (insect damage, brownwood, rot, knots) and external (limbs, bumps, bark cracks) damage. Slabs were resawn and the resulting timber was graded into structural timber according to AS 2082-1979.

Currently 36 logs cut from dominant, co-dominant, sub-dominant and suppressed trees have been assessed and graded. A further 15 logs need to be milled and assessed to complete this trial. A progress report is in preparation.

SPP No: 95/4

Title: Assessing the long-term efficacy of five different timber, preservatives, used to treat hardwood and softwood fence posts and installed at different geographic locations

Hypothesis under test: Fence posts treated in SPP 93/12 and RPP 16/90 were installed at sites throughout the different CALM regions. This will assess the performance in-service of these low durability species and determine the most suitable preservative and treatment method. Initial assessments will be after two and five year in-service.

Progress to date: Papers written on the preservative treatment trials include:

- Preservation of regrowth marri fence posts using non-pressure techniques. G K Brennan and J A Pitcher. Miscellaneous Publication 35/94 Department of Agriculture WA, August 1994.

- Creosote treatment of pine fence posts cut from the crown of 33-year-old maritime pine or 26-year-old radiata pine trees.
- Preserving pine fence posts from six-year-old farm shelterbelts.
- Preserving two-year-old Tasmanian bluegum fence posts with HTC.
- Treating swamp and rock sheoak posts with HTC.

It is planned to write a combined report on this work and also treatment guidelines for farmers.

BUNNY, FELICITY

SPP No: 93/82

Title: Biology and control of *Phytophthora citricola* in native plant communities affected by mining

Hypothesis under test:

- *P. citricola* isolates recovered from the southwest exhibit different cultural and morphological characteristics. H_0: Local *P. citricola* isolates are genetically similar as determined by isozyme analysis.
- *P. citricola* has been recovered from upland positions in the landscape, and *from* environs previously considered extreme for *Phytophthora* species. The formation of oospores (a resilient spore type able to withstand extremes in soil moisture and temperature) in soil would explain the distribution of *P. citricola* in relation to these environs. H_0: *P. citricola* does not form oospores in soil.
- H_0: *P. citricola* is a natural component of the soil mycoflora of the jarrah forest.
- H_0: All local *P. citricola* isolates are equally pathogenic to the same host.
- H_0: Phosphonic Acid is ineffective in the control of *P. citricola*.

Progress to date:

- Two morphological forms of *P. citricola* are present in the southwest, one confined to the jarrah forest and the other more widespread.
- *P. citricola* forms oospores in soil. Relative persistence of zoospores and oospores was determined, and only oospores either free in soil or in colonised plant material are capable of long term survival. Current hygiene practices for dieback (*P. cinnamomi*) control have been developed on the basis of zoospore production and survival.
- *P. citricola* has been introduced into the jarrah forest by vehicles using forest tracks, and dispersed from these tracks into adjacent healthy forest.
- *P. citricola* isolates are variable in pathogenicity.
- *P. citricola* appears sensitive to Phosphonic Acid, which may offer a practical method for the control of outbreaks of *P. citricola* in native plant communities.

Manuscripts in draft:

Seasonal effect of soil temperature and moisture on survival of different propagule types of *P. citricola* at two field sites.
Variability in pathogenicity of *P. citricola*.
Distribution of *P. citricola* on the soil surface and at depth in the northern jarrah forest.
Variability in sensitivity to Phosphonic Acid of isolates of *P. citricola*.
Factors affecting production and germination of oospores of *P. citricola* in soil.

BURBIDGE, ALLAN

SPP No: 93/26

Title: Rainforest management and monitoring

Hypothesis under test: Monsoon rainforest patches in northern Australia can be characterized by their bird communities.

Progress to date:	With respect to bird communities, WA rainforest patches have strong affinities with NT patches; flood plain sites are rare in Kimberley while some types found on drier sites are rare in NT.

SPP No:	93/33
Title:	A biological survey of the Boonanarring Nature Reserve and adjacent bushland
Hypothesis under test:	Floristic and faunistic groups can be used to characterize an area and provide some quantifiable comparisons with other areas.
Progress to date:	Almost ready for submission to *CALMScience*.

SPP No:	93/34
Title:	A biological survey of Cape Arid National Park
Hypothesis under test:	Floristic and faunistic groups can be used to characterize an area and provide some quantifiable comparisons with other areas.
Progress to date:	No action on vertebrate/vascular plant MS (MS on ant survey published in 1992).

SPP No:	93/35
Title:	Biological survey of the southern Carnarvon and northern Irwin phytogeographic districts, WA
Hypothesis under test:	• Community composition is closely correlated with physical components of the environment. • Different parts of the biota respond differently to the environment and therefore show different patterns of occurrence. • Some taxa and community types in the Carnarvon Basin are poorly conserved.
Progress to date:	Survey commenced by most officers in the Section in co-operation with scientists from the WA Museum and UWA. No conclusions to date; specimens are still being determined and data being entered in databases.

SPP No:	93/36
Title:	Assessment (in a regional context) of conservation values of VCL near Coolcalalaya
Hypothesis under test:	Floristic groups allow greater precision in delimiting phytogeographic boundaries (in this case, between the Irwin and Carnarvon Phytogeographic Regions) than available structural classifications.
Progress to date:	Analysis and specimen identification in progress.

SPP No:	93/64
Title:	Conservation status of the Nullarbor Quail-thrush
Hypothesis under test:	Quail-thrush habitat can be described in terms of vegetation composition and structure and therefore can be used to predict occurrence of the bird

Progress to date: Final report submitted to WWF; two scientific MSS submitted to journals; one small article in press in DAWA newsletter to pastoralists; recommendations discussed with regional staff. Occurrence of Nullarbor Quail-thrush can be predicted with some confidence on the basis of the density and "health" of stands of bluebush; bluebush may be declining on the Nullarbor and therefore Quail-thrush may also be declining

SPP No: 93/65

Title: Conservation status of the Western Bristlebird

Hypothesis under test:

- The Western Bristlebird is threatened and declining due to inappropriate fire regimes
- Densities at Tick Flat (Two Peoples Bay) have remained stable over the last 15 years
- Bristlebirds exhibit micro-habitat preferences within heaths at Two Peoples Bay and elsewhere

Progress to date: Research Plan produced (report to ANCA); funding obtained for Western Whipbird component; data currently being collected.

SPP No: 93/66

Title: Radio-tracking translocated Noisy Scrub-birds

Hypothesis under test: Dispersal behaviour of Scrub-birds differs between sites depending on their suitability for Scrub-birds.

Progress to date: No action in 1993 (regional staff could not catch enough birds); two females radio-tracked at a new site (Waychinicup) in 1994.

BURBIDGE, ANDREW

SPP No: 93/16

Title: Taxonomic revision of *Beaufortia* R.Br.

Hypothesis under test: Nil

Progress to date: Nil - Application made to ABRS for funds to contract a botanist to write-up work as *Flora of Australia* treatment.

SPP No. 93/17

Title: Database of mammal records from Australian islands

Hypothesis under test:

- The number of native species of mammals is greatest on large, high islands, close to the mainland or to other large islands, inaccessible to or unvisited by Aboriginal Australians or Torres Strait Islanders, and receiving a mean annual rainfall of more than 1000 mm.
- Extinctions of native species on islands during the past 200 years are associated with the introduction of species of exotic mammals.
- The number of carnivorous species of mammals of islands is less than the number of herbivorous species on the same islands, reflecting the Eltonian pyramid.
- - The mean adult body weight of the smallest species of native mammals present on islands varies directly with island area, and
  - Carnivorous species require a larger threshold area than herbivorous species.

Progress to date:	Database compilation continued. Currently contains 1713 records of mammal occurrences on 482 islands.
Manuscripts in draft:	Burbidge, A A, Williams, M R and Abbott, I. Mammals of Australian islands: analyses of factors influencing species richness.

SPP No:	93/18
Title:	Seabird breeding islands database
Hypothesis under test:	Nil
Progress to date:	Database compilation continued. Currently contains 3080 breeding records of 41 species on 468 islands.
Manuscripts in draft:	Burbidge, A A and Fuller, P J. The Western Australian Department of Conservation and Land Management Seabird Breeding Islands Database.

SPP No:	93/63
Title:	Recovery Plan for Western Swamp Tortoise
Hypothesis under test:	Nil
Progress to date:	Implementation of the Recovery Plan continued, details in Recovery Team Annual Report. SID involvement mainly concerns monitoring of population size at Ellen Brook Nature Reserve and monitoring of water quality in both reserves and on some adjacent private land.

SPP No:	93/71
Title:	Monitoring the total numbers of the Lesser Noddy *(Anous tenuirostris melanops)* in Australia and the numbers of some other seabirds breeding on Pelsaert Island.
Hypothesis under test:	Number of breeding pairs of Lesser Noddies in WA are related to the effects of extreme weather events and the vagaries of the Leeuwin Current.
Progress to date:	Last monitoring (which is carried out every two years) was IN November-December 1993.

BURROWS, NEIL

SPP No:	93/98
Title:	Effects of fire and logging on mortality, regeneration, floristic composition and structure of jarrah forest vegetation
Hypothesis under test:	Timber harvesting operations in jarrah forests have no long term negative impact on jarrah forest flora and habitat characteristics.
Progress to date:	Plots are being established and pre-treatment assessments are being carried out. No results at this stage.

SPP No: 93/99

Title: Fire regime effects on the structure and floristics of jarrah forests

Hypothesis under test: Jarrah forest flora have evolved fire adaptive traits which enable it to regenerate and persist under a wide range of fire regimes including the fuel reduction burning regime. Species diversity declines with time since last fire, but species maintain presence on site by seed banks. A fire regime which is variable both in season and fire interval is most appropriate for optimising plant diversity and structure.

Progress to date:

- 72% of species resprout following fire, the remainder depend on seed stored either in the canopy or in the soil.
- Time to first flowering after fire varies with rainfall. In high and intermediate rainfall forests, all understorey species on upland sites flower within 36 months of fire. In low rainfall forest, all plants flower within 48 months of fire. Some species on moist, lowland sites take up to 6 years to reach flowering age. The time to optimum viable seed production is estimated to be about twice age to first flowering.
- The season of fire does not significantly affect the floristic composition of seedling regeneration, but summer/autumn fires result in higher numbers of germinants and higher survival rates. There is very little germination in the absence of fire.
- Species richness is greatest in the first 4 years after fire, then steadily declines. Repeated burning under moist conditions in spring causes a decline in some obligate seed species, but no species have gone extinct, even after 5 rotations. Some riparian zone species are vulnerable to frequent fire but these sites rarely burn under spring conditions. Frequent summer/autumn burning of these sites would lead to decline and extinction of some species (eg *Banksia seminuda, Lambertia rariflora*).
- An extensive fire response data base has been established and best bet fire regimes which meet conservation and protection benefits for production jarrah forest have been proposed.

Manuscripts in draft: Post-fire regeneration strategies and time to first flowering of jarrah forest flora.

SPP No: 93/160

Title: Using prescribed fire to rehabilitate landscapes disturbed by mining exploration in the arid zones

Hypothesis under test: Mature spinifex clumps trap sand and seed. Burning the spinifex exposes soil and seed accretions to erosion by wind. Soil and seed are redistributed across the landscape, including disturbed areas such as exploration tracks. Subsequent rain and soil crusting will result in soil stabilization and revegetation of disturbed sites.

Progress to date:

- Conventional rehabilitation techniques such as ripping and artificial seeding are costly and produce poor results in hummock grasslands.
- Most soil stored seed resides beneath hummocks on soil types with low (<5%) clay content. There is little seed in inter-hummock zones. Seed is more evenly distributed in soils with higher clay content.
- The erodibilty of soils (and seed) following fire increases with decreasing clay content. Several tonnes of soil (and seed therein) per hectare is transported by wind in the first 3-4 weeks after fire on sandy soils. Soils stabilize by forming cryptogamic and physical (rain-induced) crusts.
- Soil and seed accumulates on disturbed areas. Excellent regeneration of herbs and woody shrubs occurred on and off disturbed sites following fire and rain.
- Existing hummock grassland fire behaviour models must be refined and validated before reliable burn prescriptions can be prepared for operational use.

- This rehabilitation technique is highly successful, relatively cheap and has no observed negative impacts.

BUTCHER, TREVOR

SPP No: 93/146

Title: *Pinus pinaster* - tree breeding - strategy and breeding population development.

(a) Pinus pinaster breeding population trials maintenance establishment, assessment, analysis and selection

Hypothesis under test Nil.

Progress to date:

- Assessment of key pinaster breeding trials, analysis, index and BV calculation. Most of the 2nd gen plus trees were selected at age of 9-10 years for orchards and clone banks. Trees are now 15 to 28 years of age and are close to target age. Breeding values based on this older age assessment will be more reliable. Key trials that were assessed in winter 1994 were YS22, YS49, YS56, YS65 and XS14. Important trials YS54 -> YS62 were assessed commencing in February - March 1995.
- Field checking and validation of all trees used in the breeding program to date.
- Breeding values for selections in breeding lines and seed orchards and new selections were calculated. Information was immediately required for structuring of the crossing program and for clonal grafting program.
- Cored new selections for wood.
- Prepared seedlots for major yield trials planting in 1996 at potential sites: Wanneroo coastal plain, Harvey coastal plain and south coast. Principal seed source will be the 1994 harvest from the Manjimup seed orchard.

Title: (b) *Pinus pinaster* - control crossing on breeding population for 3rd generation

Hypothesis under test: Nil

Progress to date:

- Control crossing on CALM elite breeding sub-populations 10/94.

Location	Bags	Flowers	no./bag	crosses
Manjimup	361	860	2.4	77
Nannup	57	118	2.1	18
Total	418	978	2.3	87

- Pollens were collected for the 1995 control crossing program.

Title: (c) *Pinus pinaster* - seed orchard development and research

Hypothesis under test: Nil

Progress to date:

- Proposal will be prepared for the new CALM seed orchard at the Manjimup centre; this is required if annual plantings are to increase to 1000 ha let alone 2000 ha. Clones with best breeding values for volume and stem/crown form and prolific flowering will be targeted.
- Results of the 1994 GA 4/7 application are very promising.

Treatment	cones92	cones93	cones94
GA4/7	602	899	2059
mean	25.1	37.5	85.8
control	201	261	502
mean	25.1	32.6	62.8
difference	0 %	15 %	37 %

- Grafting of 35 elite Pinus pinaster clones for seed orchard addition at Nannup; 645 grafts completed by Joe Stritof at Wanneroo in November 1994.

Title: (d) *Pinus pinaster* - breeding archives ... maintenance

Hypothesis under test: Nil

Progress to date: Ongoing

Title: (e) *Pinus pinaster* - economic evaluation of breeding objectives

Hypothesis under test: Nil

Progress to date: Nil
Economic evaluation of major breeding objectives - mill studies to determine economic weights for stem form and crown quality traits used in the breeding program and importance for a sawlog and for chipwood breeding objectives.

SPP No: 93/147

Title: *Eucalyptus globulus* tree breeding - strategy and breeding population development.

(a) *Eucalyptus globulus* - breeding population trials. Maintenance, establishment, assessment, analysis and selection.

Hypothesis under test: Nil

Progress to date:

- Yield trials EG43 (Collie), EG44 (Albany, Plantagenet) and EG45 (Albany airport) were planted in 1994. EG46 (Esperance) was not planted due to paucity of rainfall and also the lack of quality seedling stock.
- Breeding Population Trial [BPT] established in 1995 using the additional CSIRO seedlots purchased in 1993. All Co-op seed has been divided and distributed to CALM and BTF. Seedlots were sown at Manjimup nursery in 1995; trials at Collie, Albany and Busselton remain to be planted.
- Breeding Population trials on BTF land were assessed for response to drought in October 1994. Trait is under moderate genetic control and was included in index for selection of trees for grafting in October 1994.
- Richard Mazanec used pilodyne on PLUS TREES located on BTF land to obtain a ranking for wood density. These data were immediately included with all available data for PLUS trees to select trees for grafting in the 1994 grafting program at Manjimup.

Title: (b) *Eucalyptus globulus* - clonal orchard development (40% plus improvement seed program)

Hypothesis under test: Nil

Progress to date:

- Manjimup grafting 10/94, 4000 rootstocks
  Additional selections from BTF land trials mainly for archives and top breeding value trees with good flowering potential for seed orchards.
  Grafting of new selections commenced at Manjimup in October 1994. Because of the drought tolerance trait, excellent pilodyne data and our last opportunity to harness genes from the BTF trials, the grafting program was extended to 4000 grafts, using all available rootstocks at Manjimup. Grafting was completed in late October 1994
- Serial grafting 1994/95 (->6000 rootstocks) continued at Wanneroo. Clones are transferred to Como clonal archive when they are finished with at Wanneroo. Scion material from ortets will be increasingly used to ensure that we are multiplying the best genes for the orchard program.

- Considerable time was put into supplemental pollination at Manjimup clonal orchard.
- Unit 1 planting of the Manjimup clonal orchard was completed in 1994. Again there was considerable immediate post-planting mortality. Failed grafts were replaced in September and again in November.

Summary of UNIT 1 planting -

Pyear	planted	survival at 12/11/94
1990	145	33
1991	130	59
1992	219	151
1993	664	285
1994	1729	1492

Summary of UNIT 2 planting -

Pyear	planted	survival at 12/11/94
1994	924	909

Title: (c) *Eucalyptus globulus* - OPSSO development (15 - 20% improvement seed program)

Hypothesis under test: Nil

Progress to date:
- Seedling sorting and packing, and planting of an 8 ha OPSSO area at Mt Barker location 1025.
- Replanting of a 1 ha area at Collie, Bowelling OPSSO and infilling of Gnangara OPSSO.

SPP No: 93/148

Title: *Pinus radiata* - tree breeding - strategy and breeding populations development

(a) Pinus radiata Breeding population trials maintenance, assessment, analysis and selection

Hypothesis under test: Nil

Progress to date:
- Progeny trials RS12, RS19, RS20 and RS21 were assessed during the winter months. Breeding values were calculated for best trees and families. Information used in August for NUCLEUS and BREEDING population control crosses. New PLUS trees from these trials were grafted in October for HAPSO.
- Progeny trial assessment commenced in January 1995 at Busselton RS.22-25(1985), RX.07(1985), RS.32(1989)at Kirup RS.26(1986), RX.14(1988).
- Status of ALL CALM *Pinus radiata* breeding population trials was reviewed and POCS sheets in Region and District Offices were updated.

Title: (b) STBA -control crossing on nucleus and main populations

Hypothesis under test: Nil

Progress to date: The 1994 STBA crossing program commenced at Manjimup in July and finished in September with removal of last isolation bag. CALM contributed more than half of the STBA program involving 862 isolations, containing 2917 flowers.

Title: (c) CALM - control crossing for cutting donors and breeding

Hypothesis under test: Nil

Progress to date: The STBA program was given priority. The local program crosses were carried out as time permitted, with 156 isolations containing 418 flowers.

Title: (d) *Pinus radiata* - SEARCH 85 gene resource

Hypothesis under test: Nil

Progress to date:

- As all seedlots from SEARCH85 families from Harvey Weir had not been extracted before August 1994, the planned nursery sowing in September was deferred. This is fortuitous as there is a large globulus nursery and planting program in 1995.
- Search/85 trials inspection
  RS.29(1987) RS.30(1987)
  RS.33(1989) RS.34(1989)
  RS.35(1990) RS.36(1990)

Title: (e) *Pinus radiata* - HAPSO development and research

Hypothesis under test: Nil

Progress to date:

- HAPSO grafting (n = 2000) of best breeding value trees in CALM and STBA programs for GROWTH, FORM, DISEASE RESISTANCE and WOOD DENSITY carried out at Manjimup by Mike Cully.
- HAPSO management studies
  - MH 1995 studies; seed studies from MH01 trial.
  - GA 4/7 studies on clonal variability in 1994 and 1995.
  - wet pollination, preliminary study.
  - hedge management
  - artificial pollination effectiveness
  - fecundity studies for HAPSO breeding value weights.
- Cutting hedges development - sowing of control cross seed for the cutting hedges.

Title: (f) *Pinus radiata* - *Phytophthora cinnamomi* disease resistance

Hypothesis under test: Nil

Progress to date:

- PR6420 - cytoplasmic inheritance study finished in December 1994. Most resistant individuals will be set as cuttings for GRS. Inheritance is under very strong genetic control and it is immaterial if parent is either female or male. My strategy to plant HAPSO rows with tolerant females still allows use of susceptible males with high breeding value for other traits.
- PR6421 - STBA nucleus population; this study commenced in summer when seedlots were available.

Title: (g) *Pinus radiata* - clonal archive maintenance

Hypothesis under test: Nil

Progress to date:

- RX08 and RX12 (1986) at Vasse 7, sucker control and fertilizer application to grafts
- Inspection and maintenance of other archives

Title: (h) *Pinus radiata* - cambria population gene pool deployment

Hypothesis under test: Nil

Progress to date: Eldridge/Firth radiata provenance collection seed is deteriorating in storage; Guadalupe seed was planted out by the STBA in South Australia in 1994. We have a special interest in the Cambria provenance and should plant isolated Genetic Resource Stands in WA. To do this requires 20-40 ha of land to be set aside together with full funding for site preparation, establishment and long term management.

CARSTAIRS, STEVE

SPP No. 93/80

Title: Rapid identification of species of *Phytophthora*

Hypothesis under test: That isozyme analysis will be a more rapid and cost-effective method of identifying *Phytophthora* isolates than the traditional morphological methods currently in use.

Progress to date: New project, commenced March 1994 (1 yr contract).

Methodology has been developed, cultures have been acquired for species with insufficient representation in our collection, and examination of intraspecific variation of locally-occurring *Phytophthora* spp is progressing according to plan. VHS staff are being trained in the use of the technique. Interspecific comparisons and evaluation of the two methods will follow.

CHAPMAN, ALEX

SPP No: 93/14

Title: Publication of the Census of Western Australian Plants

Hypothesis under test: Nil - the aim is to restructure *Green's Census* into a corporate database format with efficient access and storage of information concerning the nomenclature of the state's flora. Apart from limited redesign of forms and reports this phase of the project is complete and the focus of the project is now the entry and validation of names and related information, with the aim of publishing the much expanded Census both electronically via the corporate computing network, and in hard-copy form in 1995.

Progress to date: Databasing of the backlog of names is now largely complete for the vascular plants.

COATES, DAVID

SPP No: 93/42

Title: Conservation biology of Western Australia's rare and threatened flora

Hypothesis under test: Nil

Progress to date: Of the nine sub-projects, one on threatened orchids was due for completion this year. A report has been submitted to ANCA. Of the other sub-projects work is continuing as follows:

1. Endangered *Lambertia* species:

(i) Initial assessments of the impact of *Phytophthora* on populations of *L. echinata* sub. sp. *echinata, L. orbifolia* and *L. fairallii* have been completed and recommendations for control are in preparation.

(ii) Research on the population dynamics and genetics of *L. orbifolia* has been completed. This includes the submission of an Honours thesis (Curtin University) on "The Conservation Requirements of the Threatened Species *L. orbifolia*".

2. Endangered *Stylidium* species:
(i) Seed biology research is continuing on *S. coroniforme* with successful smoke treatment protocols being applied to plots in the field and in laboratory germination studies.
(ii) S. scabridum was re-surveyed on the Wallaby Hills NR and new populations surveyed near Dowerin. Management recommendations are in preparation for these critical populations.

3. Endangered *Dryandra* species:
Population genetic and mating system studies have commenced *on Dryandra ionthocarpa* ms, initial surveys of the two *D. montana* ms populations and two *D. mimica* populations to assess *Phytophthora* impact have been completed. Funding has been approved from ANCA which will now enable more detailed research on these species.

4. *B. brownii:*
(i) Paper on breeding system in press in Australian Journal of Botany.
(ii) Studies on pollination biology and population dynamics have been completed and final reports received from Curtin University.

5. *B. verticillata:*
Research on pollination biology and population dynamics has been completed. This includes the submission of an Honours thesis (Curtin University) on "The Conservation Biology of *B. verticillata*".

6. Endangered *Eremophila* species:
The annual report of a two year ANCA funded program has been completed and submitted to the Endangered Species Program.

Manuscripts in draft: Conservation genetics and population ecology of five rare and threatened Western Australian orchids.
Population dynamics and seed biology of endangered *Eremophila* species.

SPP No: 93/43

Title: Seed biology, seed bank dynamics and long term germ plasm storage of Western Australian flora particularly rare, threatened and commercially utilised taxa

Hypothesis under test: Nil

Progress to date: A literature review of on seed biology and seed bank dynamics of Western Australian native plants has been completed. This was to provide a basis for further research, however, this has been delayed due to lack of funding.

Manuscripts in draft: Seed biology and seed bank dynamics of Western Australian native plants

SPP No: 93/44

Title: Development and coordination of a quadrat based monitoring system for endangered flora

Hypothesis under test: Nil

Progress to date: Various CALM, DAWA, UWA and Curtin University staff have been contacted in relation to monitoring methods, and data storage and analysis. Several sites have been selected for trial analysis and a standard report form for recording site based data which can be used by research and operations staff, and volunteers has been prepared.

CROMBIE, STUART

SPP No: 93/101

Title: Preliminary survey of the effectiveness of *Banksia grandis* removal in reducing potential *Phytophthora cinnamomi* host material in the northern jarrah forest in the medium term

Hypothesis under test: Nil - the aim is to document the effectiveness of the FIRS *Banksia grandis* removal program in reducing the stock of *Phytophthora cinnamomi* susceptible roots in multiple use forest.

Progress to date: Field work has been completed. 3 treatment types x five line transects (50 m x 10 m). Excavations of 12 root systems (3 each of *Banksia* trees, saplings and coppiced saplings). Overall, the three *Banksia* removal programs examined have reduced the size of *Banksia* in the populations but have not substantially reduced the number of *Banksia* on each site. The longest roots on mature *Banksia's* exceed 12 m but few roots of *Banksia* saplings (to 2 m) exceed 1 m. *Banksia* removal is therefore likely to increase the number of root-to-root movements required for *P. cinnamomi* to advance uphill but is also likely to increase the number of roots available by increase the density of *Banksia* plants.
Effect of treatments on root length density and on root network connectivity has not been determined.

SPP No: 93/102

Title: Water relations and growth of jarrah on high, moderate and low impact dieback (*Phytophthora cinnamomi*) sites

Hypothesis under test: Nil - the aim is to improve estimates of growth potential and survival of trees on dieback affected sites in the northern jarrah forest.

Progress to date: *Phytophthora cinnamomi* dieback reduces jarrah diameter growth to an average 80% of control growth rates. Annual mortalities were less than 5%. The effect of dieback on site wood production (Mean Annual Increment) was not determined.

Trees on dieback affected sites grow more slowly than in healthy forest and occasional deaths occur. As a result MAI on dieback affected sites is likely to be negative. However, the persistence of jarrah on many dieback sites for decades in many instances may have conservation value for the understorey. The possibility that persisting jarrah has been selected for genetic resistance may also warrant their retention or the encouragement of regrowth from coppice to provide seed.

SPP No: 93/152

Title: Measuring transpiration in *Pinus* spp. using the Heat Pulse Velocity (HPV) technique

Hypothesis under test:

Nil - the aims are:

- To develop expertise in using HPV technology to measure water use in trees and shrubs.
- To measure total annual water use and seasonal water use patterns of *Pinus* species planted by CALM in WA.
- To estimate minimum and optimal stored water requirements for *Pinus* in WA.
- To measure changes in water use by *Pinus* spp. in response to fertiliser application and stand thinning.

Progress to date:

Heat pulse loggers have been installed in ± thinned and ± fertilized *Pinus radiata* and *Pinus pinaster* stands at Myalup and sapwood parameters for calculation of sap fluxes have been determined.
Method has been developed for calibrating water use by large pines *in situ* by the cut stem technique. Weather station has been established.

SPP No: 95/1

Title: To compare chemical and biological methods for the control of *Armillaria* in regrowth karri

Hypothesis under test: Metham sodium and biocontrol fungi are equally effective at controlling *Armillaria* in regrowth karri stumps.

Progress to date:

- In 1993 *Armillaria* fruited more frequently on the control stumps than the treated stumps.
- In 1994 *Armillaria* fruited more frequently on the control and two of the biocontrol treated stumps than on the chemically treated and the other biocontrol treated stumps.

Manuscripts in draft: A comparison of chemical and biological methods for control of *Armillaria* in regrowth karri.

DAVISON, ELAINE

SPP No: 93/124

Title: Inoculation of *Pinus radiata* seedlings with different mycorrhizal fungi

Hypothesis under test:

- Sterile seedlings can be raised in the laboratory.
- *P. radiata* seedlings can be infected with different mycorrhizal fungi under sterile conditions.
- *P. radiata* seedlings can be infected with different mycorrhizal fungi under non-sterile conditions.
- Mycorrhizal fungi will persist on roots of plants grown in containers.
- Mycorrhizal fungi will persist on roots of plants grown in open nursery beds.

Progress to date:

- Sterile seedlings can be raised in the laboratory.
- *P. radiata* seedlings can be infected with different mycorrhizal fungi under sterile conditions.
- *P. radiata* seedlings can be infected with different mycorrhizal fungi under non-sterile conditions.

Manuscripts in draft: Inoculation of *Pinus radiata* seedlings with different mycorrhizal fungi.

DE TORES, PAUL

SPP No: 93/54

Title: The effect of fox control on the utilisation of habitat by the mainland Quokka, *Setonix brachyurus*

Hypothesis under test: Fox predation is restricting mainland populations of the quokka to predation refuges. In the absence of fox control, quokka habitat is defined as dense, creek line vegetation in broad valleys. In the presence of adequate fox control, quokka populations will expand and occupy a wider range of habitat.

Progress to date: Survey work indicates that in the absence of predator control, quokka populations are restricted.

SPP No: 93/142

Title: Translocation of the Western Ringtail Possum, *Pseudocheirus occidentalis*

Hypothesis under test:

- Rehabilitated Western Ringtail Possums can (in the presence of predator control) be successfully translocated outside the species existing range and within its former known range.
- Western Ringtail Possum can be translocated to similar and different habitats within its former known range.
- DNA sequencing is applicable for genetic and taxonomic studies of the Western Ringtail Possum and for comparisons between the Western Ringtail and the Common Ringtail.

Progress to date: Monitoring of released rehabilitated animals at Leschenault Peninsula indicates that translocation has been successful. Confirmation will be subject to comparison with survivorship data from a wild population. Tissue samples have been collected for DNA analysis.

SPP No: 93/157

Title: Control and ecology of the Red Fox in Western Australia - Native fauna response to 1080 baiting over large areas at three baiting frequencies

Hypothesis under test:

- Predation by the red fox is limiting abundance of native fauna within the northern jarrah forest of Western Australia.
- 1080 baiting throughout the northern jarrah forest will enable native fauna to increase in abundance and range.
- 1080 baiting throughout the northern jarrah forest will enable successful re-introduction (repatriation) of native fauna otherwise restricted to predation refuges.

Progress to date: Field experimental design has been revised and now includes 4 treatment areas, namely three 1080 baiting treatments (baiting at 5 baits/km^2 2 times per year, 4 times per year and 6 times per year) and an unbaited control. Pre-treatment survey has been completed and demonstrated low abundance of CWR fauna within all treatment areas.

Monitoring (radio-telemetry and trapping) of resident native fauna has commenced. 1080 baiting of 2 and 4 times per year treatment areas has commenced. Baiting of 6 times per year treatment scheduled for January 1995. An index to fox density has been derived for all treatments. Woylie release sites have been selected. Release of woylies within the two and four baitings per year treatments is scheduled for January 1995.

Fauna abundance within the northern jarrah forest is relatively low (when compared to similar habitat where 1080 baiting has been undertaken, ie. Batalling). Indices to fox density indicate fox density is low compared with abutting agricultural areas.

FARR, JANET

SPP No: 93/103

Title: Quantitative population monitoring of gum leaf skeletonizer *Uraba lugens* and impact assessment on jarrah crowns

Hypothesis under test: Nil - the aim is to maintain monitoring of GLS populations until next outbreak occurs and determine outbreak threshold levels.

Progress to date: GLS populations have been monitored from the latter part of its initial outbreak in Western Australia, through decline and "stabilization". In Jan '94 populations again started to increase. It is predicted that Jan '95 populations will again increase due to a dry winter and a mild to warm spring in 1994.

SPP No: 93/104

Title: Distribution of gum leaf skeletonizer in Central and Southern forest regions

Hypothesis under test: Nil - the aim is to provide an early warning system for increased incidence of GLS in the Central and Southern Jarrah forest regions and identify areas where outbreaks may begin.

Progress to date: Individual districts are participating in collection of data.

SPP No: 93/105

Title: The influence of pheromones in the mating behaviour of *Tryphocaria acanthocera* (Coleoptera: Cerambycidae)

Hypothesis under test: Pheromones are used by *T. acanthocera* to locate and select mates.

Progress to date: Light trapping was moderately successful in pilot run but unsuccessful in '93, '94 season. Conclusions from unsuccessful trapping season - return to original sites where beetles were caught. Progress includes construction of olfactometer to test insects; adaption of field trapping methods to increase efficiency and safety.

SPP No: 93/154

Title: Impact of wood boring insects on wood quality in regrowth karri in relation to site quality

Hypothesis under test: Karri on poor quality sites is more prone to borer attack.

Progress to date: Light trapping for SPP93/105 was targeted at poor or marginal karri sites. No beetle captures indicated that hypothesis may need revision, however other problems in this trapping season may have significantly affected catch. Sites for sampling are to be determined.

FRIEND, GORDON

SPP No: 93/72

Title: Effects of prescribed burning on invertebrate communities in Durokoppin and east Yorkrakine Nature Reserves

Hypothesis under test:

- Prescribed burns have no impact on the abundance and species and community composition of invertebrates inhabiting remnant semi-arid shrublands (null hypothesis).

- Responses to fire will depend on an organism's life history characteristics, particularly its requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- Resilience of invertebrates to fire is greater in these seasonally dry shrublands and woodlands than in the more mesic and less seasonal forested habitats of the south-west.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to fire.

Progress to date:

High intensity burns were carried out in autumn 1989 (Durokoppin) and autumn 1991 (East Yorkrakine). Data on the impact of the Durokoppin fire on spiders were collated and analysed by Strehlow (1993) as an Honours dissertation, Murdoch University. The fire had a significant short-term impact on spider abundance and species richness, with web building species being much more severely affected than ground-dwelling and burrowing forms. Recolonization occurred from the immediate survivors of the fire and from immigration of spiders from the adjacent unburnt areas. The impact of the fire was mitigated by a relatively wet winter and mild, wet summer following the burn which allowed rapid recovery of the spider community.

As with the Stirling Range National Park study (old RPP 16/89 now completed), environmental variables appeared to be the principal factors determining the rate and extent of recovery of the spider populations after fire. Ordination of the spider family data by years showed that although the 1989 fire caused a significant divergence in similarities between burnt and unburnt sites in the year following the fire (1990), by 1991 the ecological distance between control and impact sites was similar to that before fire. Interestingly however, the community composition of all sites in 1991 was significantly different from other years. Post-fire succession of the spider communities tended to move not towards the original pre-fire state, but to a new transient state of the undisturbed communities (Strehlow 1993). This outcome suggests that no steady state existed with respect to spider community composition, and that the effects from a single fire event were only temporary, and secondary to those caused by seasonal and year-to-year variability in environmental factors.

Manuscripts in draft:

Impact of high intensity fire on spider communities inhabiting semi-arid shrublands of Western Australia.

SPP No:

93/73

Title:

Effects of three fire regimes on ground-dwelling invertebrates in jarrah forest

Hypothesis under test:

- Prescribed burns have no impact on the abundance and species and community composition of invertebrates inhabiting jarrah forests (null hypothesis).
- Responses to fire will depend on an organism's life history characteristics, particularly its requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- If significant impacts do occur, those due to frequent fires will be greater than those due to less frequent fires, and those due to spring burns will be greater than those arising from autumn burns.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to fire.

Progress to date:

This study commenced in spring 1988, and was envisaged as a long-term project with spring and autumn sampling continuing for many years. An autumn burn on two of the eight 200 x 200m plots was conducted in 1992, and spring burns were carried out on a further two plots in 1993. Difficulties were encountered imposing the frequent summer fire regime due to the low fuel accumulation levels, and it is considered impractical to burn this habitat type at greater than normal frequency. Most of the samples collected over the past 5 years have yet to be sorted and collated.

SPP No: 93/74

Title: Effects of prescribed burning on small vertebrates in Tutanning Nature Reserve

Hypothesis under test:

- Autumn prescribed burns have no impact on populations of small vertebrates inhabiting remnant semi-arid shrublands and woodlands in a wheatbelt nature reserve (null hypothesis).
- Species responses to fire will depend on their life history characteristics, particularly their requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to fire in the longer term.

Progress to date: This study commenced in 1986 and continued with regular sampling until May 1992. The project is now in a long-term monitoring phase with resampling occurring in spring (November) every second or third year. A moderate to high intensity autumn burn conducted in a 100ha block on Tutanning during autumn 1990 had only a short-term effect on small vertebrates. Within 12 months of the burn small lizards and mammals (eg. the little long-tailed dunnart *Sminthopsis dolichura*) were at similar abundance levels to those in the unburnt control area. However the fire, together with a massive locust plague in summer 1991, has had a significant impact on the regeneration of Rock Sheoak (*Allocasuarina huegeliana)* stands, and on the abundance of Red-tailed Phascogales in the area (completed RPP 21/90).

SPP No: 93/75

Title: Effects of spring and autumn prescribed burns on small vertebrates in jarrah forest

Hypothesis under test:

- Spring and autumn prescribed burns have no impact on populations of small vertebrates inhabiting jarrah forest (null hypothesis).
- Species responses to fire will depend on their life history characteristics, particularly their requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- If significant impacts do occur, those due to spring burns will be greater than those arising from autumn burns.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to fire in the longer term.

Progress to date: A high intensity autumn burn conducted in Fleay's block during autumn 1993 had only a short-term effect on small vertebrates. Within 12 months of the burn small lizards and mammals (eg. the mardo *Antechinus flavipes*) have returned to pre-fire abundance levels. Larger mammals such as Brush-tail Possums, Woylies and Chuditch are affected more by the presence or absence of feral predators than by prescribed fire.

SPP No: 93/76

Title: Prescribed burning and the conservation of invertebrate communities in the jarrah forest of Western Australia

Hypothesis under test:

- Prescribed burns have no impact on the abundance and species and community composition of invertebrates inhabiting jarrah forests (null hypothesis).
- Responses to fire will depend on an organism's life history characteristics, particularly its requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- If significant impacts do occur, those due to spring burns will be greater than those arising from autumn burns.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to fire.

Progress to date:

Pre-fire data collection commenced in spring 1992 in an area (Fleay's Block) which was burnt at moderate to high intensity in April 1993 (as part of Ian Abbott's SPP 93/96). Regular post fire sampling has continued in this area, and the project expanded to include 12 further grids (2 in each of 2 replicates of spring, autumn and no burn plots, each approx 1000ha) in the Batalling area following the acquisition of external funding through WWF Australia. A part-time consultant (P van Heurck) is now employed on the project (commenced mid 1994), and it is closely integrated with the vertebrate work (SPP 93/0075). Sorting and data collation are up to date but no analyses have yet been carried out.

SPP No: 93/115

Title: Effects of timber harvesting on small vertebrates in medium rainfall jarrah forest

Hypothesis under test:

- Logging operations in jarrah forest, involving small-scale gap creation (clearfelling) and shelterwood thinning have no impact on resident populations of small vertebrates (null hypothesis).
- Species responses to timber harvesting will depend on their life history characteristics, particularly their requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- The retention of "habitat trees" in clearfelled coupes significantly ameliorate the impacts of timber harvesting on arboreal species.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to logging in the longer term.

Progress to date:

This project is part of a multidisciplinary study examining the effects of timber harvesting on the jarrah forest ecosystem. Field work commenced in February 1994, and logging is scheduled to be carried out in the study areas in summer 1995 and summer 1996. It is too early in the project to formulate conclusions.

SPP No: 93/155

Title: The effects of logging and fire (edge effects, habitat trees) on birds of the jarrah forest

Hypothesis under test:

- Logging operations in jarrah forest, involving small-scale gap creation (clearfelling) and shelterwood thinning have no impact on resident populations of birds (null hypothesis).
- Species responses to timber harvesting will depend on their life history characteristics, particularly their requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- The retention of "habitat trees" in clearfelled coupes significantly ameliorate the impacts of timber harvesting on arboreal species.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to logging in the longer term.

Progress to date:

This project is part of a multidisciplinary study examining the effects of timber harvesting on the jarrah forest ecosystem. Field work commenced in February 1994, and logging is scheduled to be carried out in the study areas in summer 1995 and summer 1996. It is too early in the project to formulate conclusions.

SPP No: 94/7

Title: Effects of timber harvesting on terrestrial invertebrates in medium rainfall jarrah forest

Hypothesis under test:

- Logging operations in jarrah forest, involving small-scale gap creation (clearfelling) and shelterwood thinning have no impact on invertebrate communities (null hypothesis).

- Species responses to timber harvesting will depend on their life history characteristics, particularly their requirements for food and shelter, and on this basis should be predictable and able to be modelled.
- The retention of "habitat trees" in clearfelled coupes significantly ameliorate the impacts of timber harvesting on certain invertebrate groups.
- Effects of season, locality and year-to-year variability in climate generally outweigh any changes attributable to logging in the longer term.

Progress to date: This project is part of a multidisciplinary study examining the effects of timber harvesting on the jarrah forest ecosystem. The invertebrate component (ie this SPP) is being undertaken as a PhD. program by Karin Strehlow through Murdoch University. She is jointly supervised by Gordon Friend (CALM), and Drs Jenny Davis and Stuart Bradley (Murdoch). Field work commenced in February 1994, and logging is scheduled to be carried out in the study areas in summer 1995 and summer 1996. It is too early in the project to formulate conclusions.

FRIEND, TONY

SPP No: 93/15

Title: Systematics, zoogeography and phylogeny of the terrestrial amphipods of Australia

Hypothesis under test: This is descriptive project which does not test any hypothesis.

Progress to date: Identifications of 700 of 1000 collections are complete. There are 64 species of landhopper found so far in Australia, of which 37 are undescribed. Illustrations of eight of the new species have been produced to date. Maps of all species based on current identifications have been produced using MapInfo or MAPLOT. First draft of DELTA character set produced for production of descriptions, key and data set for phylogenetic analysis.

SPP No: 93/144

Title: Quenda translocation methods

Hypothesis under test:
- Soft release (into enclosures) produces a higher survival rate than hard release (no enclosures).
- Translocation in spring produces a higher survival rate than release in autumn.

Progress to date:
- In the first trial, only hard release was tried. Survival rates were very high (90% of released animals survived the first two months). The soft-hard comparison planned was abandoned.
- A spring release has produced high survival (100%). An autumn release is planned for 1995.

Manuscripts in draft: The reintroduction of the quenda *Isoodon obesulus fusciventer* (Marsupialia: Peramelidae) to the wheatbelt of Western Australia

SPP No: 93/145

Title: Factors affecting the establishment of populations in the numbat re-introduction program

Hypothesis under test:
- Predation by feral cats is a significant factor in the success of the numbat reintroductions.
- There is no difference in the success of establishment of captive-bred numbats versus wild caught numbats in reintroductions.
-

Progress to date:

- Predation by cats occurs at Karroun Hill, but not as frequently as predation by raptors. Population viability analysis is being used to determine the significance of cat predation in success of establishment.
- Release of four captive-reared (wild-bred) numbats in 1993 produced relatively good survival, breeding and establishment in the release area. In 1994, 10 captive-bred and 10 captive-reared animals will be released in the same area in order to compare the relative contribution of animals from each source to the resulting population.

Manuscripts in draft: Reintroduction and the numbat recovery program.

SPP No: 93/149

Title: An assessment of the effect of fox control on populations of the Red-tailed Phascogale

Hypothesis under test: The implementation of fox control by use of standard 1080 baiting methods causes an increase in the population size of red-tailed phascogale numbers.

Progress to date: There is no significant difference in red-tailed phascogale population densities between long-term baited and unbaited reserves. This could be an effect of habitat differences between reserves. Baiting on previously unbaited reserves has only just started, so there is no information on the effect of implementing baiting programs. ANCA will fund the monitoring of the post-baiting response for another two years, by which time any response is expected to be detectable.

SPP No: 93/163

Title: Genetics and ecology of the Western Barred Bandicoot

Hypothesis under test:

- Between-island differences are greater than within-island differences, using DNA sequencing.
- Between-island crosses (Bernier and Dorre Is) produce fertile offspring.
- Different vegetation types on Dorre Island support significantly different WBB population densities.

Progress to date

- Ear tissue material has been collected from both islands but not analysed yet.
- Animals from both islands are now in captivity and put together on 3 December 1994 but no young have been recorded by 13 December.
- Dune vegetation and travertine scrub support more WBBs than *Scaevola*-dominated steppe and *Triodia* grassland.

GIBSON, NEIL

SPP No. 93/37

Title: Floristic survey of coastal communities of the Warren botanical subdistrict

Hypothesis under test:

- Floristic groups allow greater level of precision in delimiting plant communities than available structural / geomorphological classifications.
- Rare and restricted community types occur in the Warren
- Some community types are not well reserved.
- Some community types are seriously threatened.
- Some rare flora is closely correlated with particular community types.
- Community composition is closely correlated with geomorphology, rainfall, distance from coast, and seasonal moisture regime.

Progress to date: Analysis 80% complete

SPP No: 93/38

Title: Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain

Hypothesis under test:

- Floristic groups allow greater level of precision in delimiting plant communities than available structural / geomorphological classifications.
- Rare and restricted community types occur on the coastal plain.
- Some community types are not well reserved.
- Some community types are seriously threatened.
- Some rare flora is closely correlated with particular community types.
- Community composition is closely correlated with geomorphology, rainfall, distance from coast, and seasonal moisture regime.

Progress to date:

- Floristic groups did show greater level of precision in delimiting plant communities.
- Thirteen rare community types were identified on the coastal plain
- Only 24 of the 43 floristic groups and subgroups can be considered well reserved on present knowledge.
- One community type is considered critically threatened, 2 are considered endangered and a further 26 are considered vulnerable or susceptible.
- 19 new populations of DRF were recorded. most of these taxa appear highly correlated with particular community types.
- Community composition was most closely correlated with geomorphology and seasonal moisture regimes.

Manuscripts to date: Bushland plant survey with the community - Swan Coastal Plain Survey. Proceedings of *Nature Conservation: The role of networks* Conference.

SPP No. 93/166

Title: Floristic survey of the Goldfield woodlands

Hypothesis under test:

- To determine the regional and local variability in floristic composition of greenstone woodlands.
- To determine their conservation and reservation status.
- To determine if DRF is closely correlated to particular community types.

Progress to date:

- Established 64 plots in the Bremer Rg area.
  Established 61 plots in the Parker Rg area.

SPP No. 94/13

Title: Monitoring effects of Dawesville Channel on the vegetation of the Peel - Harvey estuary

Hypothesis under test:

- Opening of the Dawesville channel will significantly impact the fringing vegetation of the Peel - Harvey estuary.
- Opening of the Dawesville channel will significantly impact on the DRF populations in the seasonal wetlands of Austin Bay Nature Reserve.

Progress to date:

- Established monitoring transects and plots in seasonal wetlands and along Harvey River.
- Coordinate Murdoch in establishing 12 transects in fringing vegetation around the estuary.
- There was no obvious impact to the seasonal wetlands over the first spring following the channel opening.

GIOIA, PAUL

SPP No:	93/51
Title:	SID Corporate Data Register
Hypothesis under test:	Not applicable
Progress to date:	SPP under review

GLOSSOP, BRETT

SPP No:	94/1
Title:	Improvement of solar kiln drying from modelling
Hypothesis under test:	Nil - the aim is to assess benefits of new control strategies or devices in a solar timber drying kiln.
Progress to date:	The modelling language has been chosen, model specification designed in consultation with Mr Bob Fuller (Uni of Melbourne) and programming partially written.

SPP No:	94/4
Title:	Determination of drying schedules for WA timbers using a batch kiln
Hypothesis under test:	Nil - the aim is to determine efficient drying schedules for various WA hardwoods using a small batch kiln. The intended product is value added dry appearance grades.
Progress to date:	Schedules for 25, 38 and 50 mm thick marri boards have been determined and are available to the industry and public now. It was found that marri dries 50% slower than jarrah - for which there is no explanation as yet. This slower drying will not preclude marri being used but will contribute to dry marri's high price. Work has begun on regrowth karri boards confirming popular opinion that the timber is extremely difficult to dry without degrade. So far, two charges of 25 mm thick regrowth karri have been dried. The second charge dried in 55 days (which is slow) and resulted in more than 55% of Prime Grade. This experiment revealed that surface checking in karri develops deeply although closing readily towards the end of drying (thus becoming invisible). These surface checks have reopened in high humidity laboratory conditions. This is of concern since these surface checks may reopen once the timber is in service- a problem still to be discussed and resolved. A 38 mm charge is currently drying. Several extra fittings and measurements have occurred for collaborative acoustic emission work with the University of Tasmania on regrowth karri. This work will continue as time and opportunity occurs. Drying of blue-gum will commence shortly in the new experimental batch kiln. This new kiln - designed and built mainly by WURC staff - allows the speed of schedule development to be doubled. Anecdotal evidence suggests blue-gum which has had lower limbs pruned regularly has potential in high value dry products.
Manuscripts:	"Drying Marri Boards Using a Conventional Batch Kiln" "Recommended Drying Schedules for Appearance Grade Marri"

HALSE, STUART

SPP No:	93/23
Title:	Survey of Magpie Geese and other waterbirds in the Kimberley
Hypothesis under test:	Nil
Progress to date:	Nil - external funding not received.

SPP No:	93/24
Title:	Giardia in Straw-necked Ibis
Hypothesis under test:	Nil
Progress to date:	Field work completed

SPP No:	93/162
Title:	Aquatic invertebrate surveys and atlas
Hypothesis under test	Water chemistry determines which ostracod species occur in a wetland.
Progress to date:	The ostracod work is a 1 year project which began this year. Ostracods at 19 sites in the South-West are being sampled four times during the year and a series of water chemistry parameters are being measured. The project complements work being done on 45 lakes in Victoria by Lynda Taylor, ANU. July and October samples have been collected and identified. Other work done under the SPP includes invertebrate sampling at Lake Gregory in 1989 and 1992, on the mudflats east of the mouth of Cambridge Gulf (Kimberley) in 1993 and in central interior areas in 1992. This work is now being written up or is ready to write up. Conclusions to date include (1) the aquatic fauna of the northern Kimberley has a much stronger Asian affinity than hitherto recognized. (2) Lake Gregory has a freshwater fauna and lacks salt-specialists, in spite of being generally regarded as a salt lake. The lack of salt-adapted fauna probably results from the isolation of the lake and its atypical water regime for the region. (3) the invertebrate fauna of Ellen Brook Nature Reserve and claypans of the central interior are similar.
Manuscript in draft:	The aquatic invertebrate fauna of Lake Gregory.

SPP No:	95/6
Title:	Monitoring river health initiative - Western Australia
Hypothesis under test:	Aquatic macroinvertebrates, at family level, can be used to assess significance of pollution or disturbance in streams.
Progress to date:	This is a 3 year project which began in April this year. The contract for the major part of the funding was signed in August. The project structure has been organized - field and lab work will be shared by CALM, Murdoch, Edith Cowan University and UWA with CALM being responsible for the analysis and writing up. Mr Michael Smith has been given a consultancy by CALM to do much of CALM's share of the work. The project revolves around sampling the macroinvertebrate fauna of *c.* 200 'pristine' reference sites and 20 disturbed monitoring sites 4 times over 2 years

and modelling the occurrence of various taxa in relation to stream characteristics. Each group has chosen 50-odd reference sites and 5 monitoring sites during reconnaissance fieldwork in April/May. These sites were sampled for the first time between August and November and we have begun identifying the animals collected.
The design of the project has been tightly controlled by the funding body (LWRRDC) and discussions about their expectations and the level of funding we received are continuing. There are no conclusions to date, although preliminary analysis of samples in the field supports the idea that pristine and disturbed sites have a different family-level composition.

HARPER, RICHARD

SPP No: 93/123

Title: Performance of *Eucalyptus globulus*, planted on farms, in relation to soil and site attributes

Hypothesis under test: Survival and growth of *E. globulus* is related to soil and site factors

Progress to date: Although there are strong indications that soil and site attributes have a strong bearing on the survival and growth of *E. globulus*, these relationships are not simple. In many plantations deaths are due to drought, caused by shallow soils (see SPP 93/0130), whereas in other plantations deaths may be due to other influences on rooting patterns such as salinity and waterlogging. More detailed studies of the effects of different sub-soil conditions on root exploitation of sub-soils are required, and a research proposal to the Land and Water Resources Research and Development Corporation (LWRRDC) was prepared in conjunction with Dr K Smettem, The University of Western Australia, and Dr P Farrington, CSIRO Division of Water Resources.
This study will assist in referring of the criteria and methods used for land selection for *E. globulus* plantations.

SPP No: 93/130

Title: Determining the cause of death of *Eucalyptus globulus* grown on shallow soils on the Darling Plateau

Hypothesis under test: Widespread deaths of *E. globulus* in plantations on the Darling Scarp are due to shallow soils

Progress to date: The soils of three P89 plantations (Hagen, George and Eckersley) on dissected granitic terrain on the Darling Scarp, near Harvey and Waroona, were examined with 60 back-hoe pits. Tree survival two years after planting (1991) was independent of all soil and site factors and averaged 79% of those trees initially planted. Deaths occurred in all plantations in the summers of 1992/93 and 1993/94. In May 1993 mean tree survival in each plantation was 52, 67 and 75%, and in May 1994 40, 34 and 71%, respectively. Tree survival following last summer can be related to several soil factors. Rates of survival were less on soils (a) <2 m deep compared to >2 m deep (42 vs 69%), (b) with weak sub-soil structure compared to strong structure (43 vs 61%) and (c) where ironstone gravels were absent (41 vs 70%). Mean predominant height and basal area at age four were related to sub-soil structure, but not to soil depth or the occurrence of ironstone gravels. Each of the soil factors (soil depth, sub-soil structure and occurrence of ironstone) is related to soil water storage volume, the latter factor as an indicator of deep weathering profiles, rather than affecting water storage *per se*. This study was restricted to stands of one age-class, on soils with broadly similar geology, and in areas with relatively high rainfall (>800 mm); to further develop these relationships a larger array of plots should be studied. Such a study will determine whether the recent drought deaths were a function of abnormal seasonal conditions, or of stand age.

Manuscripts in draft:	Soil requirements for *Eucalyptus globulus* plantations - preliminary results and recommendations
SPP No:	93/151
Title:	Site specific silviculture: making management decisions for *Pinus radiata* plantations on the basis of a site's water relations
Hypothesis under test:	Relationships exist between the survival and growth of *Pinus radiata* and soil water supply. A soil classification can be developed, on the basis of differing amounts of available water, which indicates (a) the potential productivity, (b) the risk of mortality (from drought and wind throw) and (c) the best thinning and fertilizing practice
Progress to date:	Nil
Manuscripts in draft:	Land evaluation for forestry in Western Australia
SPP No:	93/158
Title:	Physical resource assessment team
Hypothesis under test:	Systematic evaluation of the soil and hydrological constraints of an area prior to plantation establishment will reduce the risk of failure. Such physical resources information (soils/hydrology/geomorphology) is an essential component in managing the wider CALM estate.
Progress to date:	This service is being adopted to a limited extent by the Afforestation Program.
Manuscripts in draft:	Internal CALM report by S Ward and T Reilly on completion of each property evaluation. See also SPP 93/151.

HOPKINS, ANGAS

SPP No:	93/90
Title:	Effects of fire on plant species and communities at Tutanning Nature Reserve (A25555)
Hypothesis under test:	Ecotones reflect a pronounced change in plant species composition (rather than just one or two physiognomically dominant species) which is strongly correlated with edaphic factors. Physical location of ecotones would be little-affected by a major disturbance (fire) because of the strength of the influence of soil type on the pattern of distribution of plant species.
Progress to date:	Data from all sampling episodes for the 1990 fire experiment from 1986-1992 have been checked and entered. Data for the 1990 fire experiment have been analysed using numerical analysis programs including PATN. A seminar on ecotones was presented as part of the Divisional Seminar Program. Additional field data for the 1990 fire experiment have been collected (soil profiles for all quadrats and 1994 floristic composition for 49 quadrats). Location of the ecotones as determined on the basis of floristic composition is not the same as that determined purely on the basis of vegetation structure. The location of the ecotones was not correlated with any identifiable physical factor such as soil type, drainage, topography. Fire altered the position of the ecotones which then migrated as regeneration proceed.
Manuscripts in draft:	Woodland-shrubland ecotones at Tutanning Nature Reserve, Western Australia.

SPP No: 93/91

Title: Development of the Departmental monitoring program

Hypothesis under test: Nil - the aim is to operationalize existing knowledge and results of research. Individual monitoring projects, established by operations staff, will be designed around hypotheses.

Progress to date: A National Workshop on Monitoring of Australia's Biodiversity was organised jointly with CSIRO Institute of Natural Resources and Environment and individuals from other States. This was held in Canberra, 10-11 May 1994 and attended by about 100 scientists and resource managers.
A seminar on monitoring was presented as part of the Divisional Seminar Program.
Discussions have been held with other relevant participants in the Department's Monitoring Program particularly to resolve logistic issues.
A discussion paper on the background to the Department's monitoring program has been drafted.
A bibliographic data base is being developed.

Manuscript in draft: Options for long-term monitoring of arid and semi-arid terrestrial ecosystems in Australia.

SPP No: 93/165

Title: Ecological studies, Lesueur National Park (and adjacent areas)

Hypothesis under test: Two very similar, adjacent, lateritic mesas are floristically similar. We sought to identify possible reasons for any differences. We collected data on soils, particularly those in the valley between the mesas, because of the posited relationship between plant distribution patterns and soils : the deep sandy soils in the valley could act as a barrier to migration of plant species between mesas.

Progress to date: Data from all sites in the Lesueur region have been entered into a data base and validated. Some preliminary analyses have been performed.
Advice has been provided on the Draft Management Plan for the Lesueur National Park and the State Planning Commission's Central Coast Region Strategy.

Manuscripts in draft: A comparison of the flora and vegetation of two adjacent lateritic mesas in the Lesueur National Park, Western Australia.

SPP No: 94/3

Title: Regional assessment of the conservation status of vegetation units throughout Western Australia

Hypothesis under test: Nil - the study aims to:

- To assemble a GIS data base which can be used for making assessments of values of land for nature conservation and for setting priorities for acquisition, management etc.
- To provide an up-to-date assessment of the conservation status of the vegetation units described and mapped by JS Beard (and FG Smith) within Western Australia at a scale of 1:250,000 (including identification of possible rare and threatened communities and ecosystems).
- To identify areas of land supporting vegetation units not adequately represented in the conservation reserve system.
- To examine theories related to reserve adequacy and design using a local data set.

Progress to date: The project commenced in June 1994 with the appointment of a consultant GIS scientist. Beard's vegetation data set has been assembled and the data are now being validated.

KINNEAR, JACK

SPP No: 93/83

Title: FRNP mammal population responses to baiting

Hypothesis under test: There is a minimum level of baiting required over a large area to produce a population response by:

- prey indicator spp ie, sp shown to have responded to fox control.
- prey spp not yet shown to be impacted by foxes (ie, a range of small mammals).
- ground dwelling birds eg, malleefowl, ground parrots (A Burbidge).

Progress to date: The park was divided into E-W sections and the W. section has been baited twice yearly since 1991. In 1993 it was determined that this baiting regime has reduced (and maintained) the fox population to a level 20-30% of its original level. The current program in progress is designed to measure population trends. A new pit-trap fence line was designed and trialed.

SPP No: 95/5

Title: A conservation strategy for the Western Desert Rock-Wallaby

Hypothesis under test: Nil

Progress to date: An expedition was made to the Calvert Range (18-31 August). Trap lines were set up, baits were laid on foot and by vehicle; spotlight surveys were carried out and the distribution of rock-wallabies was mapped. The results were not encouraging; only 3 rock-wallabies were caught and none were sighted. Clearly, the population has suffered a catastrophic decline.
The original plan was to bait twice years, but because the situation is now critical, I have amended the plan by increasing the baiting frequency to 4 times per year. Two feral cats were shot and one was poisoned using fresh liver baits. Cat control may now be the critical factor limiting population growth as they do not readily take fox baits.

Manuscripts in draft: Identification of rock wallabies in the Calvert Ranges, Little Sandy Desert, Western Australia.

KOMOREK, BARBARA

SPP No: 93/81

Title: Control and management of *Phytophthora cinnamomi* in native plant communities

Hypothesis under test: Nil - Aim is to determine the mode of action of the fungicide.

Despite considerable research uncertainty about the mode of action of phosphonate remains. Frequently the conclusion is drawn on the basis of comparing the concentrations of phosphite ion found *in vivo* that control the pathogen with inhibitory levels obtained *in vitro*.
Aerial application of phosphonate is a feasible method for the control of *Phytophthora*.
There are three aerial application field trials being conducted in the south-west with the aim to assess the effectiveness of this type of phosphonate application in the control of *Phytophthora* dieback. We aim to provide information on the appropriate rates of application, the duration of protection achieved by aerial spraying and to determine when re-spraying is required. There is an effective concentration of phosphonate residues that controls *Phytophthora*.
Currently we have no knowledge of the persistence of phosphite ions in native

plant species. This information is essential in developing an effective management program of protecting native plant communities from further decline and imperative as a first step in understanding the mode of action of the chemical.

Progress to date:

The results so far indicate aerial spraying of the chemical is a promising method of application. When phosphonate (10%) was applied to banksia populations at the rate of 60 l/ha the number of cumulative deaths in treated plots increased only slightly (as some plants had been infected when the chemical was applied), whereas in untreated plots the increase was very high.
Phosphonate can be delivered to plant canopy effectively. Chemical analysis of plant material shows that phosphonate is retained in the tissue for some time. The longevity of phosphonate in plants is being determined.
Application of 10% phosphonate at 60 l/ha does not have any effect on the rate of growth of treated plants.
This method is the most suitable if long fronts of infection are to be treated. It permits treatment of most remote areas cost-effectively, without disturbance to the treated and neighbouring areas, therefore eliminating any possibility of accidental spread of the disease.
A glass house experiment was set up to measure the concentration of phosphite ion over time and correlate with plant performance as well as lesion development. The effect of repeated application of the fungicide on the duration of protection is also being evaluated.
Plants are harvested periodically for chemical analysis.
The control plants in this experiment died around two months after inoculation. All the treated plants (apart from couple of plants in the lowest concentration - 0.2%) are health.
We conducted an *in vitro* experiment with the following conclusions:
- Concentrations of phosphite ion that completely inhibit growth of the pathogen *in vitro* depend on the level of phosphate in the medium.
- They also vary greatly between different *Phytophthora* isolates.
- Phosphonate has to be added to the medium after autoclaving as it is oxidised to phosphate in high temperature. The results indicate that inhibitory levels of phosphonate may be lower than previously reported and for our isolates range from 2 to 5 ppm in the low phosphate medium.

Manuscript in draft:

Effects of phosphonate on *in vitro* growth of *Phytophthora cinnamomi* isolates at different levels of phosphate

LANDER, NICHOLAS

SPP No:

93/5

Title:

WA flora descriptive taxonomic database research and pilot development

Hypothesis under test:

Nil - the aim is to design a database

Progress to date:

Subproject 1
Draft database design prepared.
SPP was developed to construct a Paradox database management system to enable two-way data transfer from DELTA applications.
Survey of electronic book tools for alternative presentation of taxonomic data has been completed. Mosaic is the tool of choice.

Subproject 2
Focus has been on databasing Rare and Endangered taxa. Of a total of 282 DRF taxa 182 have now been fully DELTA coded; 14 (Acacias) have been partially coded. 86 taxa remain of which 32 will be completed by the consultant under the current contract, which should be done by 2nd week of February. This leaves 54 taxa requiring coding.

Discussions with Corporate Relations Division concerning production of a book combined with presentation of the data in both Intkey and Mosaic formats on a CD and for network distribution are still in progress.

SPP No: 93/6

Title: Taxonomic studies in the Asteraceae, tribe Asterinae

Hypothesis under test: Nil - the aim is to revise several genera in this important family.

Progress to date: ABRS funding for this project has not been forthcoming for the past two years and progress has been slow, especially with revisionary work in *Olearia*. The DELTA database of genera in the tribe Astereae world wide is now complete, but recent publications suggesting an alternative classification by Guy Nesom (US) necessitate the extension of this database to accommodate many new concepts.

Manuscripts in draft: Papers in draft form are:
The *Olearia axillaris* group in WA
Two new WA genera (Asteraceae: Astereae) from the Pilbara Region of WA
New species of *Olearia* from eastern Australia
Australian macrocephalous *Olearia* species
Review of the genus *Erodiophyllum*

LANE, JIM

SPP No: 93/58

Title: Quantitative field assessment of nutrient inputs by surface runoff into Lake Clifton (Yalgorup National Park) an internationally significant wetland

Hypothesis under test: Lake Clifton receives significant nutrient inputs via surface drainage from agricultural land along its eastern boundary. Buffer strips of native riparian vegetation are effective in reducing these inputs.

Progress to date:
- The existing buffer zones on the east side of Lake Clifton are *in toto* inadequate to prevent nutrient-rich surface water from reaching the lake.
- Wide buffers of native vegetation are more effective than narrow buffers in reducing nutrient inputs to the lake.
- Surface water discharges into Lake Clifton are lower in volume but substantially higher in nutrient concentration than groundwater discharges.
- Fencing along parts of the eastern shore is inadequate to prevent cattle from damaging riparian vegetation and depositing nutrients directly into the lake.

Manuscripts in draft: Nutrient content of surface water discharge into Lake Clifton (Yalgorup National Park).

SPP No: 93/59

Title: Development of guidelines for monitoring of Australia's Wetlands of International Importance (Ramsar Convention)

Hypothesis under test: Not applicable

Progress to date: Guidelines drafted

SPP No: 93/60

Title: Monitoring of wetlands in nature reserves and national parks of south-western Australia

Hypothesis under test: Long term monitoring of key attributes of wetlands in the conservation estate aids in the understanding of natural processes and provides a means of assessing the need for and effectiveness of management intervention at both the wetland and catchment level.

Progress to date:

- Due to the existence of long term (10 yrs +) cycles in rainfall patterns, many wetlands undergo substantial, natural, long term changes in physical, chemical and biological attributes.
- Strategic monitoring of a range of appropriately selected parameters assists in assessment of potential impact of proposed activities on nature conservation values of wetlands.
- Long term monitoring also assists in the setting of limitations on potentially harmful activities and in assessing the actual impacts of those activities

SPP No: 93/61

Title: Assessment of the role and importance of the Vasse-Wonnerup floodplain in the maintenance of waterbird populations

Hypothesis under test: The Vasse-Wonnerup floodplain is important both as a waterbird habitat and as a buffer against disturbance of the very substantial waterbird populations of the estuaries themselves. Current land use practices on the floodplain have both positive and negative impacts on the nature conservation values of the floodplain and the estuaries. There is potential to improve the nature conservation values of this wetland system through modifying land use practices.

Progress to date:

- The floodplain is used by substantial numbers of waterbirds during winter and spring.
- Waterbird populations of Vasse-Wonnerup are highly sensitive to human intrusion.
- Sensitivity of species to disturbance varies. Importantly, in mixed species flocks the whole flock responds with the same sensitivity as the most disturbance-sensitive species.
- Breeding activity on the floodplain is lower than expected. This is probably due to dramatic fluctuations in water level during the breeding season, stock access in places, feral predators and other factors.

Manuscripts in draft: Study of the use by waterbirds of the floodplains of the Vasse and Wonnerup estuaries. Phase 1 Report.

SPP No: 93/62

Title: Management of the Busselton wetlands: control of water levels and other perturbations and their impacts upon breeding of the Black Swan (*Cygnus atratus*)

Hypothesis under test: The current, artificial water level regimes of Vasse and Wonnerup estuaries impact adversely upon breeding attempts by Black Swan.

Progress to date:

- Current water level management practices result in dramatic falls in water level during the swan nesting season during dry years at least.
- These falls result in some swan nest mounds being stranded and cause nest desertion and predation by foxes.
- Grazing of potential nesting areas by horses and cattle prevents successful nesting by reducing the amount of material available for nest construction and/or by direct physical damage to nests.
-

- Monitoring of water levels, swan nesting activity and success should be continued for at least one more year to assess impact of flood events.

Manuscripts in draft: Black Swan nesting and water level management on Busselton wetlands.

MACFARLANE, TERRY

SPP No. 93/8

Title: Taxonomy and inventory of WA flora: legumes, grasses and lilies

Hypothesis under test: Nil - the aim is to contribute to inventory, information and identification of the WA flora.

Progress to date: Further data acquisition, problem solving and writing on *Thysanotus*, *Urodon* and *Pseudochaetochloa*, and receipt and description of a new *Wurmbea* species.

Manuscripts in draft:

- *Wurmbea saccata* (Colchicaceae), a butterfly pollinated new species from Western Australia.
- A new species of *Neurachne* (Poaceae) from Western Australia.
- A taxonomic review and associated DELTA database for *Thysanotus* (Anthericaceae).
- *Pseudochaetochloa australiensis* and *Pennisetum arnhemicum* (Poaceae) are the different sexes of a dioecious species.
- A revision of *Urodon* (Fabaceae).

SPP No. 95/8

Title: Taxonomy of new, rare and priority plant species of the southern forests

Hypothesis under test: Nil - the aim is to establish a formal taxonomic treatment for selected plant species of the southern forest area, especially taxa of conservation concern.

Progress to date: Extensive field collections have been made, both special-purpose and in conjunction with the Southern Forest flora recovery plan, in which Tony Annels and I are participating. The main outcome will be papers clarifying the taxonomic situation for selected plants, and the published recovery plan. In some cases the papers can be written fairly quickly, in other cases longer term work is necessary owing to the need to examine specimens or for further field work. We have established an active collaboration, most importantly with Roger Hearn, who has responsibility for conservation matters in the Southern Forest Regional office, but also with CALM and external scientists. In the latter case, we have had mutually beneficial interaction with such people as S Jacobs, K Wilson, B Briggs & L Johnson (NSW), K Lemson (UWA), C Dunlop (Darwin), A George, and M Trudgen (Perth).

Manuscripts in draft: A new species of *Hydatella* (Hydatellaceae) from Western Australia.
Anthocercis sp. (Solanaceae), a new species from near Walpole, south western.

SPP No: 95/9

Title: Taxonomic database of WA plant genera

Hypothesis under test: Nil - the aim is to develop a taxonomic database for use as an identification tool and general taxonomic data source, as part of a planned integrated departmental collection of databases.

Progress to date: Approximately 350 genera covering the WA representatives of about 30 families have been entered. Extensive data quality upgrading has been carried out on the whole database this year. A working INTKEY database and good quality descriptions have been produced.

MARLOW, NICOLA

SPP No: 93/57

Title: Control and ecology of the red fox in Western Australia

Hypothesis under test:
- Do foxes compensate for a significant (75-80%) population reduction by:
  (i) surviving longer as adults
  (ii) producing more cubs
  (iii) increasing cub survival?
- Is fox dispersal influenced by a significant population reduction? If so,
  (i) are buffer zones effective in reducing fox immigration into areas of high conservation value? If not,
  (ii) what is the optimum time of fox baiting within reserves to produce the most cost effective baiting strategy?

Progress to date: Data are being collected on the survival of foxes in the study site where the population has been reduced. The survival of all foxes in the 'no treatment' site has been low and so only limited data on fox survival can be gathered. It is too early in the experiment to be able to reach any firm conclusions.

SPP No: 94/9

Title: The development of microsatellite probes to investigate the social organization of foxes

Hypothesis under test:
- Does the mated pair social system predominate in Western Australia?
- What are the mating strategies and minimum contact rates of foxes in Western Australia?

Progress to date: Final laboratory analyses are being undertaken.

MASLIN, BRUCE

SPP No: 93/1

Title: Systematics of Western Australian species of *Acacia*

Hypothesis under test: Nil - the aim is to provide descriptions of new WA species of *Acacia* ahead of their inclusion in the Flora of Australia volumes, and to develop a DELTA database for those taxa on the Department Priority Flora List.

Progress to date. Six manuscripts have been completed, refereed and submitted to *Nuytsia* for publication, four of these papers will appear in the December issue of the journal and the remaining two in the first issue of 1995. 63 taxa new to WA are described in these papers along with numerous lectotypifications and redefinitions of existing taxa. 12 of the Priority List taxa included in these papers have been entered into DELTA.

Manuscripts in draft: Acacia miscellany 13. Taxonomy of some Western Australian phyllocladinous and aphyllodinous taxa (Leguminosae: Mimosoideae)

Acacia miscellany 14. Taxonomy of some Western Australian "Uninerves-Racemosae" species (Leguminosae: Mimosoideae: section Phyllodineae)

Acacia Miscellany 15. Five groups of microneurous species of Acacia, mostly from Western Australia (Leguminosae: Mimosoideae: Section Plurinerves)

SPP No: 93/2

Title: Biological database

Hypothesis under test: Nil - the aim is to collect and collate biological information held by SID staff to assist in the creation of a Corporate data dictionary.

Progress to date: Definitions of the types of data that need to be captured and on the layout of the proforma needed to gather this information has been completed. However, there has been no co-ordinated attempt to acquire data. This project has been hampered by a technical officer's secondment and the need to integrate the project with SPP 93/51.

SPP No: 93/4

Title: Use of external taxonomic expertise

Hypothesis under test: Nil - the aim is to undertake systematic studies of WA biota through the use of taxonomic experts external to CALM.

Progress to date: In May 1994 Karen Wilson (Herb. NSW) examined about 75% of our Cyperaceae collection. Apart from redetermining many specimens she provided a detailed report indicating:

- the taxa still in need of curation;
- taxonomic problems that need resolution;
- changes required to our Declared Rare and Priority Flora Lists;
- new additions (five named species) to the list of flora for the State.

She provided input, through advice, to the Flora of the southern forest region project; and is also preparing a research publication on Cyperaceae in WA. It is intended to have her return to PERTH in March 1995 to complete the work.

SPP No. 93/7

Title: Systematics and conservation status of Western Australian taxa of the genus *Tetratheca* (Tremandraceae)

Hypothesis under test: Nil - the aim is to assess the conservation status of WA taxa of *Tetratheca* and clarify their systematic relationships.

Progress to date: A paper on the conservation status of *Tetratheca* was presented to the ASBS Symposium in 1993 and a ms based on this has been prepared for publication in the proceedings of the Symposium. A paper describing two new species of *Tetratheca* has been prepared.

SPP No. 95/10

Title: Flora of Australia treatment of *Acacia*

Hypothesis under test: Nil -the aim is to finalize the treatment of *Acacia* for Flora of Australia.

Progress to date: Following resolution of long-standing funding problems for this project I was able to negotiate with ABRS an acceptable schedule for the completion of the Flora treatment of *Acacia*. The following has been completed to date:

- descriptions and maps of all taxa allocated to me (*c.* 700 species);
- illustrations of most of the 950 species which will be included in the Flora;
- reconciliation of all names included in the Flora with those given in APNI and my own card index;
- sequential numbering of all species included in the Flora (the species are arranged according to their presumed closest taxonomic affinities);
- key to species is the principle task at hand, it is expected to be finished, and tested, by June 1995.

The Flora is scheduled for publication in 1996.

MAZANEC, RICHARD

SPP No: 93/126

Title: Genetic variation in quantitive trails of exotic and endemic plantation and rehabilitation species

Hypothesis under test: Provenance variation exists in a range of eastern states eucalypts and endemic species, including oil eucalypts which have potential for use in rehabilitation on a range of sites including farmland

Progress to date:

- Measured *E. sideroxylon* trials at Wellington Catchment and Arthur River - funded by SID. Data input and checking in progress.
- Special project: Measurement of *E. camaldulensis* provenance trial at Wellington Catchment. Data input and analysed. Best trees were selected and scion material supplied to Dr Liz Barbour for grafting and hybrid section with *E. globulus*. Funded by Dr S Shea/Liz Barber. Manuscript, Provenance variation in *Eucalyptus camaldulensis* planted in the Wellington Catchment of Western Australia is in preparation.
- Trials of 4 species: *E. resinifera, E. maculata, E. pilularis, E. saligna* analysed and written up. Data were presented at Workshop 3: Revegetation of minesites using appropriate species, at the Third International Conference on Environmental Issues and Waste Management in Energy and Mineral Production. The paper; Provenance trials of four exotic eucalypts in bauxite mines in Western Australia was published in the proceedings of the above workshop.

SPP No: 93/129

Title: Karri inbreeding / out crossing studies

Hypothesis under test: Inbreeding in Karri has no deleterious effects (comparison of progeny of self-fed, open-pollinated and control cross-pollinated matings).

Progress to date: Project aborted because of drought. A crossing program was initiated at Perup Karri seed orchard, which had its first widespread flowering since it was established in 1984. The extended dry season at the site lead to heavy bud shed during Dec 1993 and Jan 1994 including 99% of the controlled crosses which had been made. A number of tree deaths also occurred. This experience suggests that while the off-site location of the orchard stresses trees into early flowering, irrigation of the Perup seed orchard will be necessary in order to set and retain useable quantities of seed. I would recommend that any future crossing studies be done at West Manjimup PPC.

SPP No: 93/131

Title: Assessing the wood quality of *E. globulus* breeding selections

Hypothesis under test: Nil - the aims are:

- Provision of quick means of assessment of basic density in *E. globulus*.
- Provision of reliable estimates of genetic parameters for basic density and other quantitive traits.

Progress to date:

- Preliminary estimates of heritability, phenotype and genetic correlations of basic density, height and diameter have been made from seed orchard thinnings near Margaret River.
- Basic density has been determined for seed trees felled for the purpose of seed collection. Promising correlation with core samples and whole tree basic density was obtained.
- Pilodyn assessment of all Bunnings Tree Farm *E. globulus* trials for the basic density of plus trees included in CALM's *E. globulus* breeding program.
- Pilodyn assessment of plus trees assessed by means of core samples in trial EG03. Regression analysis of pilodyn/core sample data has been completed.

SPP No: 93/150

Title:
1. *Eucalyptus calophylla* family provenance trial
2. Kino free marri trials

Hypothesis under test: Provenance variation exists in marri, especially in presence of kino

Progress to date: Nil

SPP No: 94/2

Title: Sandalwood host trial - Katanning district

Hypothesis under test: Establishment densities, long term growth and host relationships of sandalwood underpin the success of commercial plantations.

Progress to date: Host trial measured for height and sandalwood germination assessed. Data analysed and an interim report written and submitted to the Section Manager and Regional Manager, Narrogin.
An extension of the above trial SPP 94/0002 with 5 host species was designed at the request of Narrogin District Manager, and established on land near Katanning by Katanning staff.

McCAW, LACHLAN

SPP No: 93/85

Title: Post-fire response of mallee-heath shrubland at Stirling Range National Park

Hypothesis under test:
- The response of mallee-heath, in terms of floristic composition, structure and growth rate of seedlings is the same following fires in spring, summer and autumn.
- Grazing has an impact on floristics following fire.
- Plant life form characteristics can provide a guide as to acceptable fire frequency in shrubland plant communities.

Progress to date:
- No obvious differences are evident in floristic composition or growth rate during the four years following fires in different seasons.
- There is no obvious grazing impact, probably due to dispersed grazing pressure.
- Some plants require at least 8 years post-fire in order for first seed set to occur in the population.

SPP No: 93/86

Title: Fire-induced mosaics in semi-arid shrubland and woodland communities

Hypothesis under test:
- Extensive fires have been a regular feature of woodland and shrubland communities in the Lake Johnson and Malcolm areas during the past 50 years.
- Substantial areas may be burnt at relatively short rotation as a result of lightning fires.
- Fire frequency varies between vegetation types.

Progress to date:
- Large fires of up to 250 000 ha in extent have been burnt in the south coastal hinterland since 1960, many of them probably lightning caused.
- Lightning fire return periods as short as 7 years have been recorded in Cape Arid National Park, and may result in significant long term changes in vegetation structure and floristics.

SPP No: 93/106

Title: Increasing productivity of karri regrowth stands by thinning and fertilizing

Hypothesis under test:
- Thinning can be used to increase the proportion of stand volume increment going on to merchantable trees, across a range of stand ages and site qualities.
- Application of N, P, and trace elements will increase the rate of stand volume increment in unthinned and thinned stands.
- Thinning does not adversely affect wood quality by reducing bole length, restricting branch shed, or increasing the incidence of *Armillaria* infection.

Progress to date:
- Thinning significantly increases the rate of growth of co-dominant trees, although dominants tend not to respond as strongly to thinning.
- The increase in volume increment on co-dominant trees due to fertilizer application is much less than that due to thinning alone.
- Thinning to 400 stems/ha does not appear to significantly reduce merchantable bole length.

SPP No: 93/107

Title: Espacement effects on the development and form of regrowth karri stands

Hypothesis under test:
- Diameter growth, height growth, form and branching habit of planted karri are dependant on stand density and espacement.
- Growth rate and form of planted karri are not significantly different to those of seed-tree regenerated karri grown at the same spacing.

Progress to date: Nairn- planted 1982, remeasured 1988 and 1990 - data not analysed yet.
Wheatley- planted 1991, measured 1992 and 1993- seed tree stand thinned to 2 x 2 and 4 x 2 spacing in October 1994.

SPP No: 93/108

Title: Prescribed burning of thinning slash in young karri stands

Hypothesis under test:
- Thinning slash fuel hazard can be reduced by prescribed burning without significant damage to stems and crown of retained trees.
- Outputs of N from the site due to combustion of litter and twig fuel fractions can be minimized by undertaking prescribed burns when the litter profile is moist.

Progress to date:
- Satisfactory fuel removal can be achieved without excessive damage to the retained trees by burning in spring when the PMC > 80% and the SDI (soil dryness index) < 500. This has been demonstrated both on small plots and at an operational scale using helicopter ignition.
- Output of N through volatilization can be kept below about 50% of the total N store in the fuel by burning when the PMC > 80%.

Manuscripts in draft: Prescribed burning of thinning slash in regrowth stands of karri -
- Fire characteristics, fuel consumption and tree damage
- Dynamics of nitrogen during prescribed burning
- An operational trial using helicopter ignition

SPP No: 95/2

Title: Establishment and growth of karri stands in relation to soil characteristics.
Part 1. Measurement of soil characteristics

Hypothesis under test:
- That soil physical characteristics can be used as indicators of sustainable productivity from native forests.
- That current forest harvesting activities meet draft specifications for soil conservation as outlined in National Forest Policy Codes of Practice.

Progress to date: Work to commence in field in February 1995.
Literature research underway and a network of contacts in soil science area has been established.

McGRATH, JOHN

SPP No: 93/121

Title: Early rotation nutrition of *Pinus radiata* on ex-pasture land on the South Coast of WA

Hypothesis under test: Application of fertilizer and thus the growth rate of young *Pinus radiata* plantations in the South Coast region sharefarming plantations, can be optimised.

Progress to date: Trials have been established to examine:

- Weed control by fertiliser interactions
- Potassium responses on deep dunal sands
- Interactions between N, P, K
- Response to Phosphorus application
- Timing of fertilizer application.

The trials have been monitored for between 2 and 4 years, to date they have shown:

- Fertilisation without weed control at planting is ineffective
- Very limited responses to phosphorus on all previously fertilised sites
- Sustained responses to potassium on deep leached sands at modest application levels
- Large interaction between N and K on the deep leached sands.

SPP No: 93/122

Title: Diagnosis of nutrient deficiencies in young *Pinus radiata* using foliar analysis

Hypothesis under test: Foliar analysis can be used to assess the nutrient status of young *P. radiata* in the Mediterranean climate of Southern WA, which causes an annual cycle of water sufficiency (winter/spring) and drought (summer/autumn).

Progress to date: Three trials examining the relationships between nutrient concentrations (N, P, K) in foliage and tree growth rates have been established in the last decade. The first trial examining nitrogen is complete and the data have been analysed; the field work for the second trial examining phosphorus is complete but the data have yet to be analysed; the third trial examining potassium is still in progress.
There are strong relationships between nitrogen concentrations and tree growth. In contrast to previous recommendations the most sensitive time for sampling appears to be in spring during the rapid growth phase. Preliminary data analyses suggest that the patterns may be similar for phosphorus and potassium. Thus it appears likely that foliar analysis will provide a very useful tool in determining if plantations require fertilization. Sampling will have to be accurately timed during the growing season to maximize the sensitivity of the technique, and critical nutrient concentrations may have to be modified.

Manuscripts in draft:

- Response to nitrogen by young *P. radiata* 1. Seasonal growth patterns and water relations.
- Response to nitrogen by young *P. radiata* 2. Impact of seasonal water status on the relationship between foliage nitrogen concentrations and growth rates.

SPP No: 93/128

Title: Early-mid rotation nutrition of *Eucalyptus globulus* in south-west WA

Hypothesis under test: *E. globulus* responds to nitrogen, phosphorus and potassium on a range of sites with varying nutrient status and water status.

Progress to date: Nitrogen, phosphorus and potassium interaction and rate trials have been established on 5 separate soil types/locations - 3 in 1992 and 2 in 1993. Early results show that there is little response to phosphorus on sites with a good fertiliser history. Responses to nitrogen occurred on most sites although very fertile sites showed no response to any fertilization. There is a suggestion from one site that heavy fertilization may result in increased mortality in dry years.

SPP No: 93/140

Title: Mid rotation responses to thinning and fertilization by *Pinus radiata*

Hypothesis under test: Thinned *P. radiata* plantations responded to N and P. Define the interaction between thinning and fertilization to determine if *P. radiata* and *P. pinaster* will respond to fertilization prior to thinning.

Progress to date: Currently 6 trials are operational. Earlier trials are complete. The current trials investigate the response to nitrogen and phosphorus separately and in combination (2 trials). A further 4 trials investigate various aspects of the interaction between stand density and fertiliser response in both radiata and pinaster plantations.
The current mid rotation fertilizer recommendations are based on these and the earlier trials, the current trials are aimed at improving the fertilizer prescriptions and maximizing the wood production from the plantations.
The current data strongly suggest that more wood can be produced on the high rainfall sites by maintaining plantation stocking at higher densities than are currently used. On infertile sites large fertilizer responses are achieved in unthinned plantations.

Manuscripts in draft: Nitrogen and phosphorus increase the growth of thinned *Pinus radiata* on coastal sands in Western Australia.

McKENZIE, NORM

SPP No: 93/25

Title: Eastern Goldfields survey

Hypothesis under test:
- Physical attributes predict biodiversity patterns
- Major gaps in districts reserve system
- Land-use reducing district's biodiversity.

Progress to date: Reports for Cells 11 and 12 are in press:
- A biological survey of the eastern Goldfields of Western Australia. Part 10. The Sandstone - Sir Samuel and Laverton - Leonara Study Areas.
- A biological survey of the eastern Goldfields of Western Australia. Part 11. The Boorabbin-Southern Cross Study Area.
- A biological survey of the eastern Goldfields of Western Australia. Part 12. The Mount Elvire- Mount Manning.

SPP No: 93/26

Title: Rainforest management and monitoring

Hypothesis under test:
- Rainforests contracting with fire and cattle
- Snail biological patterns differ from those of plants etc.

Progress to date: Monitoring program continued.

SPP No: 93/27

Title: Buccaneer Archipelago survey

Hypothesis under test: Nil

Progress to date: Paper written and submitted for publication:
Biological survey of Koolan Island, Western Australia. Zoology 2.

SPP No: 93/28

Title: Ecomorphological Clues to Community Structure: Bat and Lizard Guild Studies. Bat Echolocation.

Hypothesis under test: Flight morphology and foraging ecology of bats are closely related.

Progress to date: Publication in press. Sound signatures have now been obtained for all but two of WA's species of micro-bats.

SPP No: 93/29

Title: Mandora Palaeoriver/Radi Hills Survey

Hypothesis under test: Nil. This study is a survey.

Progress to date: Nil

MOORE, RICHARD

SPP No: 93/125

Title: Oil eucalypts as a multi-purpose tree crop for the wheatbelt.

Hypothesis under test: Nil - this project aims to evaluate eucalypts as a multi-purpose tree crop for the Wheatbelt. Specific questions to be answered are:

- What is the leaf yield for various species?
- What is the oil content for various species?
- What is the effect of site (rainfall & soil type)on leaf yield and oil content?
- What is the overall productivity of oil eucalypts in a layout integrated with farming?

Progress to date:

- Established species trials at 28 locations across the Wheatbelt; 22 in 1993 and 6 in 1994. Trials compares 9 species or subspecies.
- Increased awareness amongst farmers that research into oil eucalypts a multi-purpose tree crop is being undertaken.
- Assessed survival of 1993 plantings.

SPP No: 93/127

Title: West coast pine timberbelt project

Hypothesis under test: Nil - the aims are to:

- Establish three demonstrations of pine integrated with farming using whole farm planning procedures.
- Demonstrate that pine can be used as a multi-purpose tree crop to improve agricultural productivity, to combat land degradation and to provide a commercial return for wood.
- Develop extension and training programs about integrating pines and farming in order to promote this type of farm forestry.

- Encourage farmers to adopt farm forestry practices with pine so that they can help produce the resource that is required by an expanding softwood industry.

Progress to date:

- Appointed John Winchcombe as project coordinator.
- Selected 3 sites (Dandaragan, Busselton and Boyup Brook) for the establishment of demonstrations of pine integrated with farming.
- Set up planning teams and management committees for each site.
- Carried out whole-farm planning for each site to determine where pine should be planted.
- Implemented first stage of farm plans.
- Held field days to enable farming communities to find out about Project.

Manuscripts in draft: Agroforestry for water and nutrient management.

SPP No: 93/137

Title: Pine timberbelts

Hypothesis under test: Nil - the study is to determine the quantity of wood produced by pine grown in belts and what tree management is required. Specific questions are:

- What is the chipwood yield from 5 and 6 row belts thinned to different densities?
- What is the yield of sawlogs from various densities at subsequent harvests?
- What is the quality of sawlogs from pruned, trimmed and unpruned edge trees and from pruned and unpruned trees within the belt?
- Which treatments produce F5 grade timber or better?
- What is the cost of different pruning treatments?

Progress to date:

- Collected and summarised data on chipwood yield from belts.
- Developed spreadsheet on likely returns for farmers from pine timberbelts.
- Commenced testing Victorian FARMTREE model with Dept of Agriculture.

Manuscripts in draft: *Integrating Pines and Farming* - CALM leaflet, 1994.
Tree Growing Options - internal reports for each of the three demonstration farms being established under the West Coast Pine Timberbelt Project.

SPP No: 93/138

Title: Eucalypts for high quality sawlogs, integrated with farming

Hypothesis under test: Nil - the trial is to determine the potential of eucalypts, for high quality sawlogs, as a commercial tree crop integrated with farming. Specific questions include:

- What are the growth rates and sawlog yields for different species and provenances on various sites?
- What are the management requirements and costs to produce high value logs from eucalypts at wide-spacing?

Progress to date:

- Collected and summarized height and DBHOB data for 4 and 6 year old eucalypts grown at wide spacing on 3 different sites.
- Carried out tending of wide spaced eucalypts on study sites at Busselton, Middlesex and Dinninup.
- Harvested 13 year old bluegum logs for veneering and sawmilling tests.

Manuscript in draft: Agroforestry Systems in temperate Australia.

SPP No: 93/139

Title: *Eucalyptus globulus* as a multi-purpose tree crop on the Esperance sandplain

Hypothesis under test: Nil - the study aims to answer several questions:

- What are growth rates and wood yield for *E. globulus* on various sites on the Esperance Sandplain?
- Which sites can and cannot grow *E. globulus* on the Esperance Sandplain?
- How can *E. globulus* be integrated with farming to provide landcare benefits and what are those benefits?

Progress to date:

- Established trial plots on 24 sites on the sandplain, mostly in 1992 and 1993 but some in 1989. These trial plots now need to run for a few years to see whether bluegums have commercial prospects in the Esperance region.
- Demonstrated good establishment techniques to local farming community.
- Assessed soils to 2m on most sites.
- Established permanent measurement plots (4/site) and assessed survival, height and DBHOB (of trees 3 yrs and older).
- Established bores on 4 sites to monitor the impact of tree plantings on water-table levels (DAWA).

MORRIS, KEITH

SPP No: 93/52

Title: Conservation of the Thevenard Island Mouse *Leggadina* aff. *lakedownensis*

Hypothesis under test:

- *Leggadina* on Thevenard Island is the same taxa as the mainland form.
- The introduced House Mouse has no detrimental impact on the native *Leggadina* on Thevenard Island.
- Leggadina can be successfully translocated to another island.
- The House Mouse can be controlled on Thevenard Island without impacting the native rodent.

Progress to date:

- The morphometric and genetic analyses suggest that the *Leggadina* on Thevenard Island could be regarded as a valid sub species of *Leggadina lakedownensis.*
- House Mouse numbers are greatest around the disturbed oil base and tourist resort areas on Thevenard Island.
- In undisturbed areas Leggadina numbers fluctuate seasonally but appear to have not been affected by the House Mouse.

Manuscripts in draft: Brochure prepared on project for WAPET and tourist resort.

SPP No: 93/53

Title: Recovery plan for the Chuditch *Dasyurus geoffroii*

Hypothesis under test:

- Fox baiting programs do not detrimentally impact on chuditch populations in jarrah forest.
- Management activities of prescribed burning and timber harvesting do not detrimentally impact on chuditch populations in jarrah forest.
- Chuditch can be successfully bred in captivity.
- Chuditch can be successfully reintroduced to parts of their former range.

Progress to date:

- Fox control in jarrah forest enhances chuditch populations as well as other medium sized mammals.
- Patchy spring burns have no immediate detrimental impact on chuditch in jarrah forest.
- Chuditch are relatively easy to breed in captivity.
- Chuditch can be successfully translocated.

Manuscripts in draft: The impact of fox control programmes on chuditch and other medium sized mammals in the jarrah forest.

SPP No: 93/55

Title: Reintroduction and monitoring of the Greater Stick-nest Rat on Salutation Island, Shark Bay

Hypothesis under test: The Greater Stick-nest Rat can be successfully translocated to Salutation Island.

Progress to date: Since the translocation in 1990, the population has increased from 40 to 600+. The number of stick nest constructed has trebled in the past 12 months suggesting that other natural cover is now fully occupied and the island may be approaching carrying capacity.

Manuscript in draft: This project is part of a recovery plan for the Greater Stick-nest Rat and contributions are made to the Annual Report for ANCA.

SPP No: 93/56

Title: Recovery plan for the Shark Bay Mouse *Pseudomys fieldi*

Hypothesis under test:
- The Shark Bay Mouse population on Bernier Island is not declining.
- The Shark Bay Mouse can be successfully translocated to another island.
- Shark Bay Mouse can be successfully reintroduced to the Shark Bay mainland.

Progress to date:
- The Shark Bay Mouse population on Bernier Island fluctuates seasonally with reproductive activity.
- When translocated to Doole Island, Shark Bay Mouse dispersed widely before establishing their home range areas. This has implications for mainland translocations where mice would not be restrained by the surrounding water and may need to be fenced in for some time before the final release.
- Shark Bay Mouse use a wider range of habitats on Doole as compared with Bernier Island including mangrove trees.

Manuscripts in draft: A recovery plan for the Shark Bay Mouse *Pseudomys fieldi.*

SPP No: 93/109

Title: The effects of timber harvesting and associated activities on medium sized mammals in the jarrah forest

Hypothesis under test: Timber harvesting and associated activities have no detrimental impact on medium sized mammal populations in the jarrah forest.

Progress to date:
- The Kingston and adjacent forest blocks support significant populations of several threatened mammal species.
- In areas such as Kingston where several species require suitable trees with hollows as refuge sites, the existing prescription allowing for the retention of 3 habitat trees per hectare is being assessed.
- There is considerable variation in the quality of habitat trees selected for retention during timber harvesting operations.

PATRICK, SUE

SPP No: 93/45

Title: Population surveys, conservation status and area based wildlife management programs for rare and threatened flora, including Moora District, Geraldton District, Narrogin District, Darling Scarp Endemics

Hypothesis under test: Nil - the aim is to produce Wildlife Management Programs for Rare and Threatened Flora in the relevant CALM Regions and Districts, in order to ensure and enhance, by appropriate management, the continued survival in the wild of populations of Rare and Threatened Flora in those Regions and Districts.

Progress to date: Moora: 225 taxa researched, 750 populations surveyed. Draft manuscript near completion.
Geraldton: 240 taxa researched, 190 populations surveyed.
Narrogin: 165 taxa researched, 150 populations surveyed. Draft manuscript near completion.
Darling Scarp Endemics: work has concentrated on the fire ecology of DRF *Anthocercis gracilis*. Two interim reports have been produced and a report on the field survey for the species, with information for 27 populations of other priority taxa found during the survey. An additional result has been publication of a paper on the cytology of *Boronia tenuis*.

Manuscripts in draft: Declared Rare Flora and Other Plants in Need of Special Protection in the Moora District.
Declared Rare Flora and Other Plants in Need of Special protection in the Narrogin District

PEARSON, DAVID

SPP No: 93/32

Title: Preliminary Survey of the Biological and Cultural Resources of the Ranges of the Western Desert

Hypothesis under test: Nil. This study is a survey.

Progress to date: Nil.

SPP No: 93/92

Title: Fire effects on desert vertebrates - influence of fire season

Hypothesis under test: Fires in hummock grassland, which occur in different seasons with different intensities, rates of spread and spatial heterogeneity, lead to differing recover/survival responses by terrestrial vertebrate assemblages.

Progress to date: Fires in spring and summer have resulted in profound differences in the way vertebrate communities have responded. Summer fires remove almost all spinifex cover and result in the localized extinction of a number of small mammals and reptiles, but allow the invasion of open area specialists. Patchy spring fires maintain more diverse vertebrate assemblages. Many areas of a summer burn in 1989 have not yet been colonised by mature spinifex taxa.

Manuscripts in draft: The response of sympatric *Ctenophorus* dragons (Reptilia: Agamidae) to fire.
The ecology of the Hairy-footed Dunnart, *Sminthopsis hirtipes*, in relation to fire.

SPP No: 93/159

Title: Ecology and conservation of Western Australian pythons

Hypothesis under test: The observed and perceived decline in python populations in south-western populations is due to feral animals predation and habitat changes caused by clearing and fire.

Progress to date: This study was commenced in August 1993. A mail survey of CALM staff and the public has commenced in order to establish a benchmark position of python distribution and relative abundance, and to locate populations amenable to study. Aboriginal people in the Central Desert Reserve were interviewed about species in that region. Pythons have indeed declined and become locally extinct in large areas of the Wheatbelt. The south-western population of *Aspidites ramsayi* is on the verge of extinction.

PIGOTT, PATRICK

SPP No: 93/48

Title: Weed control in populations of Western Australian rare and threatened flora

Hypothesis under test: Nil

Progress to date: Commitments to this SPP are primarily associated with redrafting a report on weeds and threatened flora prepared by Frank Obbens and myself in late 1993 for the WA Roadside Conservation Committee. The report deals with the difficulties of controlling weeds in populations of threatened flora on linear reserves in the wheatbelt, particularly those managed by agencies other than CALM.

SPP No: 93/77

Title: Bridal creeper (*Myrsiphyllum asparagoides*) control and ecology in Western Australia

Hypothesis under test: Nil - the aim is to support the introduction of biological control agents with relevant ecological and biological information on the weed.

Progress to date: The bridal creeper SPP (93/77) was optimistically based on the objectives of a SCAP grant research proposal submitted in July 1993 for 3 years work (1 FTE and project costs for CALM SID) in conjunction with CSIRO. Since approval of the SPP in September 1993 we have learnt that this SCAP proposal has not been successful, making completion of many of the Objectives in the SPP (all or part of Objectives Three - Eight) unlikely in the current financial circumstances.

Distribution of bridal creeper project
Work for this project forms the basis of objectives one and two for the bridal creeper SPP. Work on this project has been held up because a member of staff associated with the SPP (Paul Farrell formerly with LIB) has left the Department. To date a number of data-sets pertaining to the Leeuwin-Naturalist area in the South-West of WA have been assembled. These include tenure, coastline, streams, roads and bio-climatic suitability. It is also hoped that an outline of Beard's vegetation will also be available. These data-sets will be transferred to the Herbarium soon. Arrangements are being made to finish the planned GIS work (using ARC/INFO) on the Herbarium's Sun Workstation.

Workshop
The WA Roadside Conservation Committee has agreed to fund a workshop on bridal creeper in May 1995, similar to the successful Watsonia Workshop held in August 1993.

Control and integrated management
Work proposed with the Perth District at Yanchep NP and Woodmans PT to control bridal creeper with fire is added Objective Seven. Existing work on Objective Seven of the SPP has been conducted by CALM's Katanning District and Kings Park and Botanic Gardens. This work is largely unpublished and attempts would be made to encourage participation of field staff involved in this work in the forthcoming workshop.

SPP No: 93/78

Title: Ecology of understorey communities and soil seed-bank of remnant salmon gum (*Eucalyptus salmonophloia* F. Muell.) woodland near Lake Taarblin, WA

Hypothesis under test: Nil.

Progress to date: Preliminary analysis of data for the soil seed-bank experiment (formerly RPP 6/90) and plant communities for the understorey of salmon gum woodland (formerly RPP 30/89) has been carried out with Matthew Williams. Descriptive results from both experiments will form the basis of the first publishable paper (planned for *CALMScience*) for this SPP. Further analysis will examine the experimental effects of various treatments from a temporal and spatial perspective.

RYE, BARBARA

SPP No: 93/10

Title: Taxonomic review and conservation status of Western Australian members of the family Rhamnaceae

Hypothesis under test: Nil - the aim is to determine which members of the Western Australian Rhamnaceae should be included on the Priority Flora List, name any new taxa and provide means of identification for all taxa.

Progress to date: Considerable changes have been made to the Priority Flora List for the family Rhamnaceae. Several papers have been prepared describing new taxa belonging to the genera *Cryptandra, Spyridium, Stenanthemum* and *Trymalium* and providing illustrations both for the new taxa and for any additional taxa included on the Priority Flora List.
At a less advanced stage of preparation, there are two manuscripts, the first dealing with a new genus and taxa that are presently of doubtful placement, the second with a synopsis of the entire family in Western Australia. The latter gives keys, distribution maps and a comprehensive list of taxa giving habitat, distribution, flowering period, synonyms, conservation status and notes on morphological variation. These two papers will not be submitted for publication until studies of the generic boundaries in the family, which are presently being carried out by Kevin Thiele and Judy West, are far enough advanced to determine where all the doubtful species should be placed.

Manuscripts in draft: Is *Trymalium spatulatum* (Labill.) Ostenf. a legitimate name?
New and priority taxa in the genera *Cryptandra* and *Stenanthemum* (Rhamnaceae) of Western Australia.
Miscellaneous new and priority taxa in the Western Australian Rhamnaceae.
A synopsis of the Rhamnaceae of Western Australia.
Cryptandra monticola (Rhamnaceae), a new species from the Pilbara region of Western Australia.

SPP No. 93/11

Title: Taxonomic studies of species on the declared rare and priority flora list

Hypothesis under test: Nil - the aim is to undertake taxonomic research to recommend which Western Australian taxa should be included on the Declared Rare List and Priority Flora List and to facilitate the naming of those taxa which lack a formal scientific name.

Progress to date: A Paradox table has been set up giving the following data on all of the unnamed taxa currently listed on the Declared Rare and Priority Flora List:

- Which databases include them
- Who is studying them and whether they are on loan
- Name changes
- Location of specimens

A list of the main problem groups needing to be examined has been drawn up and arrangements made for two of these to be tackled by external experts (Karen Wilson for the Cyperaceae and Bob Chinnoch for the Myoporaceae). The return of Epacridaceae specimens has been requested so these can be investigated by Alex George. I am currently investigating priority taxa, especially unnamed ones, in the Apiaceae (beginning with *Hydrocotyle, Platysace* and *Trachymene*) and problems in a few miscellaneous priority species.

SHEARER, BRYAN

SPP No: 93/68

Title: Integrating strategies for control of *Phytophthora cinnamomi* with phosphorous acid

Hypothesis under test: Phosphonate can be used to regenerate disease centres infested with *P. cinnamomi.*

Progress to date:

- Integrated application:
  A combined injection/spray trial was established in infested *Banksia* woodland on private property between Nth Dandalup and Mandurah. The rate of spread of the infection front was greater in non-treated than treated plots. Unfortunately the trial was burnt mid year. Monitoring is continuing to see what can be salvaged from the trial. In April 1995, a new trial will be established in a disease centre nearby.
- Regeneration of infested sites:
  Trials have been established at three sites to test the use of phosphonate in the regeneration of susceptible species in infested areas. At two sites natural regeneration is being used, at a third site seedlings will be established from seed sown into the area. Pre-spray monitoring has commenced. It is anticipated that the plots with natural regeneration will be sprayed in autumn, 1995. Seed will be sown into the remaining plot after the first rains in 1995 and sprayed in 1996.
- Continued assessment:
  As part of determining longevity of action of phosphonate, have continued to assess injection trials. In summer 1994 trees injected in 1988 were rechallenged and lesion lengths determined. Phosphonate injected into *B. attenuata* and *B. grandis* has continued to inhibit lesion development up to 5 years after injection.
- Proposed new SPP on control of *P. cinnamomi*:
  Silica has been used to protect plants from *Pythium* infection in aquaculture. With the establishment of the above experiments, time will be available to test the possibility of using silica to control *P. cinnamomi* infection within the host in a small injection trial. Such research may demonstrate an alternative to phosphonate and demonstrate CALM's initiative in testing potential alternative treatments.

SPP No:	93/69
Title:	Use of debilitating factors and host resistance to control *Cryptodiaporthe melanocraspeda* canker in *Banksia coccinea* communities
Hypothesis under test:	Debilitating factors may occur in *Cryptodiaporthe melanocraspeda* similar to that in Dutch Elm disease.
Progress to date:	Examined morphological variation between isolates of *Cryptodiaporthe*. Spore measurements indicate that isolates are grouped according to host from which they were isolated. Variation in pathogenicity is being assessed in the field. The *B. grandis* path trial will be assessed early December. Over 100 isolates have been processed for isozyme analysis. Screening of isolates to be completed early 1995.
Manuscripts in draft:	*Cryptodiaporthe melanocraspeda* canker threatens *Banksia coccinea* on the south coast of Western Australia. *Cryptodiaporthe melanocraspeda* the causal organism of canker of *Banksia coccinea*.

SPP No:	93/70
Title:	Control and management of *Armillaria luteobubalina* in native communities
Hypothesis under test:	*Armillaria luteobubalina* can be controlled by phosphonate and debilitating factors.
Progress to date:	An injection trial has been established in a *A. luteobubalina* disease centre in *E. wandoo*. A further injection trial will be established in a disease centre in *B. attenuata* woodland in November 1994. Variation within the pathogen has been determined using isozyme analysis. Over 100 isolates have been processed.

SPP No:	93/110
Title:	Use of phosphonate to determine the effect of *Phytophthora cinnamomi* infection on growth of *Eucalyptus marginata*
Hypothesis under test:	Phosphonate can be used to control *P. cinnamomi* infection to compare growth of infected and non infected *E. marginata* in the same site.
Progress to date:	Sixty paired trees in each of 5 *P. cinnamomi* infected sites have been selected and girth and crown measurements made. Trees will be injected with phosphonate in Autumn, 1995.

SPP No	93/111
Title:	*Phytophthora cinnamomi* impact in the northern jarrah forest: A re-analysis
Hypothesis under test:	Site and vegetation characteristics can be associated with impact of *P. cinnamomi* in the northern *E. marginata* forest.
Progress to date:	Re-analysis of the vegetation data has commenced. Jarrah deaths are being analysed to identify the most useful parameter of *P. cinnamomi* impact before analysis of site data.
Manuscripts in draft:	The major plant pathogens occurring in native ecosystems of south-western Australia. Impact and symptoms of *Armillaria luteobubalina* in rehabilitation plantings of *Eucalyptus saligna* in *Eucalyptus marginata* forest of south western Australia. Control options of plant pathogens in native plant communities of south western Australia.

SIEMON, GRAHAM

SPP No: 93/119

Title: Durability of Western Australian-grown timber species

Hypothesis under test: Regrowth timber has similar durability in ground to mature timber.

Progress to date: The study has been conducted in the Accelerated Field Simulator at CSIRO Division of Forest Products, and the most recent data available are from the 184 week exposure assessment. The natural durability of regrowth and mature heartwood of jarrah, karri, marri, wandoo, WA blackbutt, and WA sheoak has been ranked. In addition, regrowth of spotted gum, red mahogany, radiata pine and maritime pine grown in Western Australia was compared with mature wood of those species from the natural occurrences.

Manuscripts in draft: The most recent report is Thornton, J D, and Johnson, G C (1993). AFS study of the natural durability of heartwood from mature and regrowth trees. IV. Results after 184 weeks' exposure. CSIRO Division of Forest Products Report.

SPP No: 93/120

Title: Improved preservation of karri power poles

Hypothesis under test: The HYCON process gives improved penetration and retention of preservative in regrowth karri poles.

Progress to date: The trial was designed to assess the feasibility of treating karri power poles using the HYCON process developed by Koppers-Hickson and CSIRO. HYCON is the equivalent of the PROCCA process developed for softwoods, using copper-chrome-arsenic preservative in an oil emulsion. The first batch of sample logs was sent to CSIRO to be dried to 30% moisture content as a prerequisite for treatment, but major barrel checking occurred. A second batch was stored under watersprays at Harvey for two months to alleviate growth stresses, then stored under cover. Some splitting still occurred, but the logs were considered suitable for treatment. Treatment is currently being done at CSIRO in Clayton.
After the trial was commenced, a SECWA policy change resulted in an agreement with CALM to provide jarrah poles only. However, this is based on a 1.5 per cent replacement rate, which is very conservative. This research will be very important with an increased replacement rate because karri poles would be required to supplement the jarrah poles, and the problems of barrel-checking and treatment must be resolved.

Manuscripts in draft: A joint report will be prepared on completion of the trial.

SPP No: 93/143

Title: Stability of timber panels constructed under different gluing regimes

Hypothesis under test: There is no difference in stability between cross-laminated and parallel-laminated panels.

Progress to date: Study completed and draft manuscript in preparation.

SPP No: 94/10

Title: Wood properties and utilization of regrowth karri

Hypothesis under test: Regrowth karri can be used more efficiently for value-added purposes with a better understanding of its wood properties, sawing, drying, and workability behaviour.

Progress to date: Regrowth karri will provide an increasing proportion of the log resource available to sawmillers, but little is known about its potential for value-adding. The trial is complementary to the assessment of the effects of borers and brownwood on wood quality currently being carried out by G Brennan.

Manuscripts in draft: A formal report with the above title will be prepared on completion, similar to the karri oak report referred to above. In addition, an Information Sheet will be prepared in association with FIF(WA).

SPP No: 95/3

Title: Wood properties and utilization of karri oak (*Allocasuarina decussata*)

Hypothesis under test: Karri oak has potential value-added uses which can be predicted from its wood properties and processing behaviour.

Progress to date: The trial was initiated following a specific request from the Executive Director to assess the potential of the species for commercial purposes. The sawmilling phase is currently being carried out, but has to be scheduled in with commercial production at the WURC. Wood properties parameters eg. density and shrinkage are being assessed as well as sawing and drying behaviour, workability and gluing properties.

Manuscripts in draft: A report with the above title is being prepared for *CALMScience*.

STONEMAN, GEOFF

SPP No: 93/94

Title: Regeneration of jarrah (*Eucalyptus marginata*) in the southern jarrah forest

Hypothesis under test: Seed-fall, the fate of seed, emergence, survival and growth of jarrah in shelterwood logged areas of jarrah forest are influenced by fire and stand density.

Progress to date: Exp A: Monitoring seed-fall in shelterwood cut forest to be burnt in autumn 1994. Seed-fall measurements began March 94. Three study areas were burnt, one in autumn 1994, another in late-winter 1994, and the third in spring 1994. Neither the autumn or winter fires promoted the mass seed-fall desired. Seedling emergence was measured in late October 1994 and there was a good stocking of new seedlings in the autumn burnt area but very few seedlings in the late winter burnt area.

Exp B: Effect of stand density and fertilizing on seed-fall. Seed-fall measurement began in Feb 94, and early results show seed-fall to be largely independent of stand density. Plots previously fertilized had less seed-fall than unfertilized plots, but this may be because the fertilizer treatment induced them to be at different stages of the flowering/seeding cycle.

Exp D: Seed-fall in relation to distance from seed-tree. Study trees have been selected, the areas are about to be burnt, and seed-fall and meteorological conditions will then be measured.

Exp H: Site preparation on dieback 'graveyard' sites and the effect on survival and growth of jarrah seedlings and *Phytophthora cinnamomi* resistant plants. Plots established, site preparation treatments done, planting completed and spring measurements of survival and height done.

Exp's C,E, F and G: No action.

SPP No: 93/95

Title: Characteristics of hollow-bearing jarrah (*Eucalyptus marginata*) and marri (*E. calophylla*) trees and coarse woody debris (CWD), their use by selected species of fauna, and the effect of logging and burning jarrah forest on them

Hypothesis under test:

- The size and abundance of hollows in jarrah and marri trees and CWD is related allometrically to tree and stand parameters.
- Allometric relationships exist between tree and stand parameters, the size and abundance of hollows in jarrah and marri trees and CWD, and the use of these resources by selected species of fauna.
- Logging-and-burning treatments have no significant impact on the abundance of hollow-bearing trees and CWD, and thus the abundance of selected species of fauna.

Progress to date:

This SPP is part of an integrated research program investigating some of the ecological effects of logging and burning in jarrah/marri forest. Work to date on the overall experiment has involved surveys of regeneration and stand characteristics which aided in setting up the overall experimental treatments at the Kingston Black study area, For project aim A, 2 of the proposed 9 study plots have been completed, and we now have data on tree and hollow characteristics of 75 trees (out of the proposed 270 trees, 180 jarrah and 90 marri). Data collected previously by K Faunt on hollows in CWD has been partially analysed, and we have a model to predict the probability of a hollow in the CWD, based on its external characteristics. Work is currently being concentrated on project aim B. Trees used by the Phascogale and Brush-tailed Possum are being identified and measured, and hollow characteristics will be measured as logging proceeds.

Manuscripts in draft:

Size and age parameters of nest trees used by four species of parrot and one species of cockatoo in south-west Australia: Critique.

STUKELY, MIKE

SPP No: 93/112

Title: Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*

Hypothesis under test: Dieback-resistant lines of jarrah can be selected from the progeny of trees surviving on long-established dieback sites.

Progress to date:

Genetically based resistance to Pc has been shown to exist in jarrah, and results were published this year. Selection of jarrah for dieback resistance is feasible. Resistant clonal selections are continuing to perform well in the field after 6.5 yr.

Seed was collected last season from 115 parents (mostly in the Northern Jarrah Forest), and seedlings are being grown for screening in early 1995.

Stage 1 has commenced, with the first planting of Pc-resistant jarrah clones in operational forest rehabilitation sites in 1994 (see SPP 94/0006).

Stage 2 will be the establishment of seed orchards, and the testing of progeny. Planning of strategies has started.

Manuscripts in draft: Field survival and growth of clonal, micropropagated *Eucalyptus marginata* selected for resistance to *Phytophthora cinnamomi.*

SPP No. 94/6

Title: Dieback-resistant jarrah establishment in operational forest rehabilitation sites

Hypothesis under test: Dieback-resistant jarrah clones can be used successfully in operational rehabilitation plantings (not on extreme graveyard sites).

Progress to date:

New project, commenced June 1994. Plots of dieback-resistant jarrah clones were planted this year on operational forest rehabilitated sites in Mundaring (John Forrest National Park), Jarrahdale, Dwellingup and Harvey Districts.

This project will ensure that dieback-resistant jarrah are used in operational plantings from the earliest opportunity, and that their performance is monitored.

VAN LEEUWEN, STEPHEN

SPP No: 93/30

Title: Biological survey of Barlee Range Nature Reserve

Hypothesis under test: Nil - this is an inventory survey.

Progress to date: Progress over the past year has been considerable with the identification of 281 plant, 27 mammal, 101 bird, 63 reptile and 5 amphibian species within the reserve. In addition, numerous invertebrates have been collected, including eleven species of mollusc which encompass six land snails, three of which appear to represent novel species. The discovery of new populations of a novel Wurmbea species, which appears to be endemic to the Barlee Range, and the collection of the Long-tailed Dunnart and Pebble-mound mouse have been highlights of the past twelve months research. Of similar significance has been the identification of a significant sub-fossil deposit containing many mammalian fragments.

Preparation of the final report due in late 1995 is under way, although data analysis has not yet begun. Compilation of a geographical information system for the reserve has commenced in conjunction with Roy Fieldgate from Land Information Branch.

This survey has highlighted the inadequacies in our knowledge of the biota of Western Australia. Preliminary results indicate that the Barlee Range Nature Reserve has significant nature conservation value and is biogeographically a significant reserve, being one of only two in the Ashburton Biogeographical Region.

SPP No: 93/31

Title: Botanical survey of Central Pilbara Uplands within the Karijini National Park

Hypothesis under test: Nil - this is an inventory survey.

Progress to date: No progress has been made on this project over the past twelve months as funding has not been forthcoming. Attempts to attract funding from ANCA as part of the National Reserve Scheme program have proven unsuccessful. The possibility of the Region providing funding, through an allocation of money from the Fire Protection Branch - Business Unit has become a possibility in recent months.

SPP No: 93/141

Title: Fire-Mulga study: burn and post-fire monitoring

Hypothesis under test: Fire has a detrimental effect on mulga communities, especially if there is a change in fire frequency. The research program is attempting to develop management prescriptions, based on quantifiable research, for managing fire in and around mulga communities.

Progress to date: Progress over the past year has been minimal, although considerable planning has been undertaken. Progress has been minimal due to the inability to successfully complete planned experimental burns due to logistical problems and the weather (it rained heavily).

This project has highlighted the vulnerability of mulga woodlands in the Hamersley Range to fire, in particular, a change in fire frequency. Research results indicate that fire significantly reduces the diversity of mulga woodland communities while promoting the expansion of hummock grasslands.

Such community change has significant impacts on the biodiversity and nature conservation values of conservation lands. This research has also indicated that in recent times (30 years) the mulga woodland communities of the Karijini National Park have significantly decreased in their aerial extent.

Manuscript in draft: Fire and its impact on the floristics on mulga woodlands in the Central Pilbara.

WARD, DAVE

SPP No: 93/20

Title: A method of assessing the distribution and abundance of Brown Boronia (*Boronia megastigma* Nees)

Hypothesis under test: It has been supposed that the wild population of Brown Boronia is declining, yet no 'hard data' exist on its former extent and density. This SPP tries to develop and test a standard, practical, reproducible method for assessing the present (and future) abundance of Boronia within forest blocks know historically to have contained it. Given the range of the species, from Harvey to Albany, there is no way that a single researcher, or even an army, can survey it all, so a method involving a combination of map-work and field checking has been developed.

Progress to date: The method involves a spreadsheet which can be up-dated as information comes to hand, and this will be handed over to Wildlife Conservation staff when the project ends. It has already been used by them to set picking quotas.
The rows of the spread-sheet represent over a hundred forest blocks, and the columns contain information on such variables as creek length, density of plants, age since last burn, etc. The model used is explicit, and even if wrong, can be corrected in a clear and systematic way.

SPP No: 93/113

Title: Primary damage caused by various methods of harvesting sprigs of Brown Boronia (*Boronia megastigma* Nees)

Hypothesis under test: Picking of Brown Boronia leads to death of the plant.

Progress to date: I have made extensive reconnaissance of boronia sites from Harvey to Walpole, but have not yet discovered any widespread death which can be directly attributed to picking. There are sometimes a few millimetres of necrosis directly below the cut or break, but that is all.
I have discussed picking methods and effects with seven experienced pickers who were recommended by District staff as being reliable, and these pickers are all of the opinion that moderate picking stimulates, rather than kills Brown Boronia. I have been with one of these pickers (Albie Milentis) to his site in Thornton Block near Manjimup. He has picked the plants there fore the past four years, and they are thriving, with abundant resprouting, and stimulation of lateral growth. The plants have a distinctly different appearance from those that are unharvested, being shorter, and of a candelabra form. Due to pruning response, they have many more pickable sprigs than the unpicked ones. This single counter example should be enough to dismiss the hypothesis of death by picking. Where death occurs it may be due to drought, old age, predator or pathogen, and these all need investigation.
If further counter examples are needed, we may consider a farm near Nannup where both wild and cultivated Boronia have been picked for over ten years. Far from dying, the bushes are vigorous, some nearly two metres high, with prolific blossom, even in dry seasons such as 1994.

WARDELL-JOHNSON, GRANT

SPP No: 93/39

Title: Landscape modelling vegetation communities of the Kent, Hay, Bow and Denmark River Catchments

Hypothesis under test: Nil

Progress to date: Conclusions relate to one of four major upland centres of endemism (southern monadnocks from Walpole to Denmark) of the High Rainfall Zone. Outcrop and swamp community-types are rich in species.

Manuscripts in draft: A floristic survey of the tingle mosaic.

SPP No: 93/87

Title: Community conservation of the Walpole Nornalup National Park (part of 93/0088)

Hypothesis under test: Most plant species flower and fruit within 10 years of fire.

Progress to date: Field work completed.

SPP No: 93/88

Title: Community conservation of the Lake Muir complex

Hypothesis under test: Nil

Progress to date: Conclusions relate to fine-scale patterning at landscape scale and extraordinary diversity and vulnerability of communities to disease.

SPP No: 93/89

Title: Conservation biology of locally endemic eucalypts

Hypothesis under test: Historical biogeography, climate, soils, floristic pattern, genetics and fire environment govern local patterns of distribution and local endemism in subdued topography.

Progress to date: Conclusions relate to limited genetic variability between populations suggesting recent contact, complexity of local climate, geology, landform and soils, and relictual status of species in the high rainfall zone. Conclusions for dominant species also relate to remainder of biota (particularly vascular plants and small vertebrates and invertebrates).

Manuscripts in draft:
A floristic survey of the tingle mosaic.
Rare eucalypts in south-western forests: a case study of two new species.
Patterns of biodiversity in moist temperate regions: lessons from an ancient landscape.
Patterns of distribution in eucalypts.
Links to the past: local endemism in four species of forest eucalypts in south-western Australia.

SPP No: 93/93

Title: Conservation biology of vulnerable frogs

Hypothesis under test: Speciation can occur in a subdued landscape.

Progress to date: Conclusions reached are that the high rainfall zone of the south-west harbours a biota equally as rich as the Interzone, that *in situ* allopatric speciation mechanisms have operated, and continue to operate at very fine scale, and that threatened taxa can be recovered by public involvement.

Manuscripts in draft: Recovery plan for the White-bellied and Orange-bellied Frogs. Wildlife Management Program No 19, Department of CALM, Perth.
Systematics, scale and biodiversity conservation: An ancient frog from the temperate forests of Australia. Patterns of biodiversity in moist temperate regions lessons from an ancient landscape.
Genetic structuring and distribution patterns in rare west Australian frogs: Implications for translocation programs.
Call structure differences between peripheral isolates of the *Geocrinia rosea* complex (Anura: Myobatrachidae) in South-western Australia.
Morphological variation in the *Geocrinia rosea* (Anura: Myobatrachidae) complex in south-western Australia.
Genetic differentiation and relationships of peripheral isolate species of the *Geocrinia rosea* group (Anura: Myobatrachidae) from south-western Australia.

SPP No: 94/8

Title: Effects of timber harvesting on birds of the karri forest

Hypothesis under test: Logging of karri forest impacts locally and short-term on the distribution and abundance of bird species.

Progress to date: Conclusions relate to resilience and speed of recovery of populations of understorey dwelling species, importance of flowering of overstorey, and importance of retained overstorey components in determining local bird community composition.

Manuscripts in draft: Mature forest remnants ameliorate the effects of logging in karri forest.

WHEELER, JUDY

SPP No: 93/13

Title: Flora of the lower south-west

Hypothesis:: Nil - the aim is to produce a user-friendly flora handbook of an area of the lower south west of WA (containing keys, descriptions and illustrations of 2000-2500 species) combined with a number of more popular colour picture booklets and *LANDSCOPE* articles. The publications anticipated are as follows:

- The main publication - A user friendly flora handbook of the lower south west of WA.
- Subsidiary publications :-
  (a) pocket booklets or *LANDSCOPE* articles on several high profile plant groups produced during the course of the main publication;
  (b) glossy publications of the common plants of different vegetation types within the area;
  (c) subsets of the main flora data for the area's major national parks.

Progress to date: Approximately half of the species descriptions have been prepared. So far 839 of these species have their characters entered into a DELTA database which will help in the production of the user-friendly key. A number of illustrations have been prepared.

A draft of the text for the first of the subsidiary colour picture publications (Common native trees of the south west forests) has been prepared. Field work has been done in order to ascertain which species will be included in some of the other subsidiary publications.

WILLIAMS, MATTHEW

SPP: 93/22

Title: Conservation status of butterflies in Western Australia

Hypothesis under test: Nil - the project aims to determine through survey the representation of butterflies in National Parks and Nature Reserves, with particular focus on those species identified as rare and endangered by the ANCA project "The Conservation Status of Australian Butterflies".

Progress to date: This project has contributed to the ANCA report "The Conservation Status of Australian Butterflies". This report identified:
1 taxon as endangered; 2 taxa as vulnerable; 4 taxa as rare;
4 taxa as insufficiently known; and 2 taxa as indeterminate.
This project has gathered sufficient data to remove 4 of these taxa from this list, and documented the presence of 3 taxa in reserves.
We have also identified a further 3 taxa, either new species or taxa not previously recorded in the State, which may be of conservation concern, and determined their distributions and representation in reserves.
Incidental to this work, the project has documented a large amount of distributional and life history information.

Manuscripts in draft: Further distributional records and natural history notes on butterflies from Western Australia.
New foodplant records and notes on the life history of the western jewel *Hypochrysops halyaetus* Hewitson (Lepidoptera: Lycaenidae).
A previously unrecognized species of *Candalides* Hubner from Western Australia.
Biological survey of Koolan Island, Western Australia. 2.

WILLS, RAY

SPP No. 93/49

Title: Development of GIS-based decision-support tools in the control of *Phytophthora* and the management of *Phytophthora*-sensitive taxa and communities

Hypothesis under test: Nil - the study aims to:
- assemble, verify and automate appropriate data sets
- interrogate data sets to answer basic management questions
- develop a model with predictive capabilities and test validity of predictions.

Progress to date: My research is establishing a GIS database on relevant spatial biophysical data and remote-sensed images to provide information on the spread of *Phytophthora* and its proximity to populations of susceptible threatened taxa, and includes a study to model the dynamic effects of infection. The objective is to provide both managers and researchers who may be unskilled in the operation of Arc/Info with a tool that will make data accessible and allow questions that were previously impossible to attempt or extremely time consuming to be quickly answered. The prototype interface developed has been designed by assessing managers needs in several informal fora and by examining approaches taken by other organisations. Current work includes analysis of historical remote-sensed imagery, evaluation of alternative remote-sensing techniques, and ground validation of existing data sets and model output.

Manuscripts in draft: Developing a GIS-based model to assist in the management and control of *Phytophthora cinnamomi.*
Developing a GIS-model to aid in the management of *Phytophthora cinnamomi.*

YUNG, MICHAEL

SPP No: 93/50

Title: Evaluation of the time series analysis techniques

Hypothesis under test: Nil - the aim is to evaluate time series analysis techniques.

Progress to date: Time Series Analysis (TSA) has become a popular statistical tool in many disciplines such as economics, physics and engineering, and more recently bio statistics, but not in CALM.
I moved to evaluate the usefulness and effectiveness of TSA to the Division's research activities by carrying out the analysis of a typical data set and discussions with research staff.
To gain a perspective of our statistical analysis practice with the current development of TSA, a literature survey was conducted for relevant and interesting application examples. They were presented in a Departmental Seminar. The statistical package SYSTAT was used for demonstration. This was also aimed at raising awareness and generating interest in TSA among staff. The clarification of a few common misconceptions was used as a motivation to use TSA. Audience appreciation was good.
TSA was suggested to be a useful tool for tree growth rate studies, wildlife management, forest disease prevention, insect outbreak control, fire control modelling, and decision support in GIS.

Manuscripts in draft: Project completed, an internal report was filed.

The science library

The three main Collections within the Science and Information Division provide an information service primarily to members of the Division and other CALM officers.

The Forest Science Library (FSL) is located at Como and holds the main stocks of books and journals on forestry. A small special collection on environmental education is held for teachers and the Library's video collection is housed here, as are Departmental publications, WA statutes and a collection of coloured slides and historical photos.

The Plant Sciences Library (PSL) is located in the WA Herbarium at Kensington and contains material on botanical subjects for use by botanists and other staff. The collection is mainly on systematic botany and related disciplines. As well as books and journals, there are also microfiche, original botanical illustrations, maps, coloured slides relating to the flora of Western Australia and an extensive collection of journal articles and reprints.

The Wildlife Science Library (WSL), located in the Wildlife Research Centre at Woodvale, holds the main stocks of books and journals on the environment, ecology, conservation, wildlife, national parks and nature reserves of Western Australia. The CALM archives are also held at Woodvale, where a comprehensive range of materials (books, journals, reports, reprints, videos, photos, etc) produced by or about the Department and its departmental predecessors (eg, the Forests Department) are retained permanently.

Each Collection is managed by a Collection Committee, comprising the Librarian and members of the Centre where the Collection is located. This Committee makes decisions relevant to their particular collection. There is also a Library Committee, where the Librarians, the Head of Group or nominee and a chairperson decide on policy matters and procedures.

As a result of transfers and resignations there are now 4 staff members; one Level 2/4 in each Library and a Level 1 assistant at the Wildlife Science Library.

The WAHL uses the database Titan; the FSL and WSL both use Inmagic. Records are transferred between Libraries using the Wide Area Network. The Joint Database has nearly 31 000 records, of which 15 000 new titles have been added over the last three years. There are public access terminals available at the FSL and WSL. Herbarium staff have access to the WAHL catalogue through Titan.

The WAHL has databased 15 053 records, of which 4 678 are incomplete. The FSL and WSL have 4 896 incomplete records, but there is a large collection of uncatalogued materials stored at the FSL because of the limited time available to include them in the database.

An extra retrieval field has been included in the main catalogue which allows the input of key words and phrases from the contents pages and indexes of books. This use of 'natural language' gives greater access to the material.

The indexing of articles in CALM publications is nearly complete, with CALM News being the only one still outstanding. The indexing of WA journals through the author and title of articles has commenced at WSL. This enables better access to material that is held within the journals. All monographic journals at WSL have interim records.

The vertical file at WSL has been indexed by author and title, so that pamphlets and newspapers clippings can be accessed through a computer search.

As a consequence of budget constraints journal acquisitions have been rationalized. Subscriptions to all journals that are not used regularly have been discontinued. Subscriptions are now limited to one copy per title and internal arrangements ensure all scientists are aware of the content of all titles received regardless of which collection they are housed in. Each Library has a core collection of important and relevant journals.

The WAHL was able to purchase some bookstock over the three years, but few books were purchased by the other two Libraries. Most new titles are gratis, either unpublished reports or publications by other Government Departments.

The FSL and WSL circulate copies of the contents pages of journals received on a monthly basis as part of an 'Alert' service. Permission to copy was sought and gained from the majority of copyright holders. Journals and new publications are displayed within the three collections. A new accessions list is included in the 'Alert', and also circulated to everyone on the Wide Area Network.

The Current Awareness Service commenced by WSL in September 1992, was instigated to help staff keep up with relevant journal articles and new books. 20% of Inter-Library Loan requests and 50% of photocopy requests came from this service. Since June 1994 the WSL has requested 843 reprints direct from the authors. 70% have been received.

Numbers of titles added to the Joint Catalogue since July 1992

Books =	6 929	Journals =	98
Monographic journals =	1 619	Reprints =	568
Indexed articles =	1 109	Indexed journals =	240
Interim books =	687	Interim monographic journals =	3 063
Interim reprints =	1 061	Maps =	1 577

Numbers of new items added to collections via purchase or exchange and gratis agreements

	FSL	WAHL	WSL	OTHERS
Books	756	609	1 419	387
Journals	30	23	48	
Monographic journals	390	109	962	
Reprints	43	176	378	
Vertical file	-	-	246	
To be catalogued	23	-	4 896	
Microfiche	-	4	-	
ILL requests		192	1 806	(FSL & WSL)
ILL requests (Other libraries)		282	516	(FSL & WSL)
Photocopy requests		154	3 128	
Loans to staff	2 850	3 279	3 444	

Journals held

All titles (including ceased and annual reports)	658	336	590
Current titles (without annual reports)	237	184	287
Number of subscriptions	51	52	76
Current exchange titles	25	113	44
Gratis titles	161	35	167

Field research sites

Science and Information Division staff are active at some 200 sites, dispersed over the whole State. Most sites are, however, located in the south-west of the State, embraced by CALM's Southern Forest Region, Central Forest Region, Swan Regions, South Coast Region, Midwest Region and Wheatbelt Region.

There is currently little activity in Kimberley Region and Goldfields Region, reflecting the intensive research effort there in the 1970s are 1980s respectively.

KIMBERLEY REGION

Lacepede Islands

PILBARA REGION

Barrow Island
Dampier Archipelago
Dirk Hartog Island
Doole Island
Dorre Island
Exmouth Gulf
Lowendale Island
Muiron Islands
Mundabullangana Station
North West Cape
Peron Peninsula
Rosemary Island
Sandalwood Peninsula
Thevenard Island
Varanus Island

MIDWEST REGION

Bernier Island
Coomalloo Conservation Park
Freycinet Estuary
Houtman Abrolhos
Lancelin Island
Lesueur National Park
Morley Island
Pelsaert Island
RGC minesite, Eneabba
Salutation Island
Shark Bay
South Eneabba Nature Reserve
Wongonderrah Nature Reserve
Wooded Island

SWAN REGION

Amphion forest block
Balmoral forest block
Bannister
Boddington
Brady forest block
Canning forest block
Canning Vale
Carinyah forest block
Chandler forest block
Churchman forest block
Clare forest block
Clinton forest block
Dwellingup
Ellen Brook Nature Reserve
George forest block
Gnangara pine plantation
Harvey District and Bunnings estate
Helena Valley
Holyoake forest block
Huntley minesite
Inglehope forest block
Jarrahdale
Jarrahdale minesite
Julimar Conservation Park
Marradong forest block
Marrinup forest block
Mundaring
Mundlimup forest block
Myara forest block
North Dandalup
O'Neil forest block
Private properties at Jarrahdale
Reservoir forest block
Sawyers forest block
Secret Harbour
Twin Swamps Nature Reserve

Urbrae forest block
Wearne forest block
West Dale
Whittakers forest block
Willowdale minesite
Yalgorup National Park

CENTRAL FOREST REGION

Arklow forest block
Batalling
Baudin plantation
Beaton forest block
Bennelaking forest block
Bombara plantation
Bridgetown
Bristol forest block
Cambrai forest block
Centaur forest block
Collie
Cordering Farm forest block
D White's farm, Dinninup
Darkan
Darrell forest block
Fleay forest blocks
G Cox's farm, Ambergate
Gervasse forest block
Godfrey forest block
Haddleton's Reserve, Boyup Brook
Haddon's farm
Hamilton forest block
Hartridge plantation Scott River
Hillman forest block
J Cutbush and N. Hopkin's farm, Busselton
Jarrahwood Cpt 7
Jolly forest block
K and J Ritson's farm, "Daneholme", Boyup Brook
Leach forest block
Leschenault Peninsula Conservation Park
Lyons forest block
McCorkill forest block
McLarty plantation
Muja forest block
Mungalup forest block
Myalup plantation
Nannup nursery site
Nundedine forest block
Palmer forest block
Ross forest block
Tallanalla plantation
Trees forest block
Trigwell's Reserve, Boyup Brook
Vasse plantation
Vasse Research Station
Vasse-Wonnerup wetlands (Busselton)
WAWA land, near Bowelling (Collie Catchment-formerly Robinson's Farm)
WAWA property on Bowelling-Macalinden Rd, Collie District
Wellington Catchment
Western forest block
Westralia forest block
Worsley minesite

SOUTHERN FOREST REGION

Alco forest block
Arnots forest block
Beavis forest block
Boorara forest block
Boyicup forest block
Brenton's Farm, Denmark
Brockman forest block
CALM land Middlesex (ex DAWA Research Station)
Cardac forest block
Channybearup forest block
Dingup forest block
Dwalgan forest block
Dordagup forest block
Eastern forest block
Hayles forest block
Johnson (Unicup)
Kingston forest block
Lindsay forest block
Long forest block
Meribup forest block
Mersea forest block
Nairn forest block
Netic forest block
Palgarup forest block
Perup Nature Reserve
Poole forest block
Quininup forest block
Price (Yornup)

R and F Notley's farm, Dandaragan
Solai forest block
Souths Brook
Spring forest block
Sutton forest block
Talling forest block
Thornton forest block
Treen Brook
Walpole-Nornalup National Park
Warren
Warren forest block
Warrup forest block
Weld forest block
Wheatley
Winnejup forest block
Yanmah forest block
Yardup forest block
Yendicup forest block
Yeticup forest block
Yornup forest block

WHEATBELT REGION

Arthur River
Beverley agricultural land
Dryandra National Park
Durokoppin Nature Reserve
East Yorkrakine Nature Reserve
Heitman's Scrub (north of Kellerberrin)
Karroun Hill Nature Reserve
near Cadoux
near Elphin
Three sites south-east of Narrogin
Tutanning Nature Reserve

GOLDFIELDS REGION

Kananda Station
Queen Victoria Spring Nature Reserve

SOUTH COAST REGION

Archipelago of the Recherche
Cape Arid National Park
Dennis (Denbarker)
Fitzgerald River National Park
Frank Hann National Park
Gull Rock National Park
Hassell National Park
Milgraum (Two Peoples Bay)
Millbrook Reserve
Near Mt Barker
Nullarbor
Peak Charles National Park
South Sister Nature Reserve
Stirling Range National Park
Thorpe (Porongorup)
Two Peoples Bay Nature Reserve
WAWA1 (Rocky Gully)
Waychinicup National Park
Wise (Porongorup)

Finance

During the Triennium, CALM moved progressively from a cash basis accounting system to accrual accounting. This has involved several important shifts in focus from inputs to outputs and from cash cost to resource usage. A key component is the identification and valuation of assets and liabilities, with the ultimate measure of performance being the quantification of how well the activities undertaken or the product of a process met a specific goal.

The total budget allocated to Science and Information Division and its predecessor, Research Division, over the past six years shows a steady decline (Figure 11). This is a reflection of successive cuts on public sector finances.

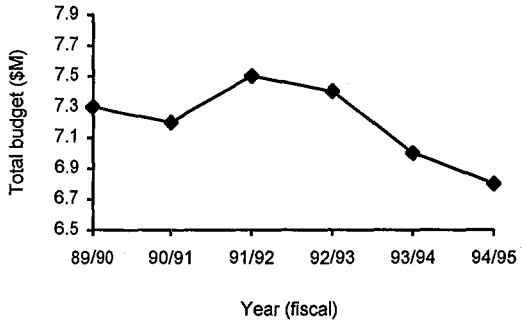


Figure 11
Science and Information Division total budget - six year trend

In recent years Science and Information Division's ratio of expenditure on salaries costs to research costs, and ratio of fixed infrastructure costs to research costs are as follows:

	salaries*: research**	fixed infrastructure†: research
1992/3	87:13	51:49
1993/4	90:10	46:54
1994/5	93:7	68:32

* salaries costs refer to salaries of permanent staff in SID
** research costs refer to monies spent on doing research
† fixed infrastructure costs refer to fixed charges such as electricity, photocopying, telephone, fax, portfolio admin, general consumables and library

As a consequence of these financial ratios in the Science and Information Division's total budget, the monies available for research from CF have declined markedly (Figure 12).

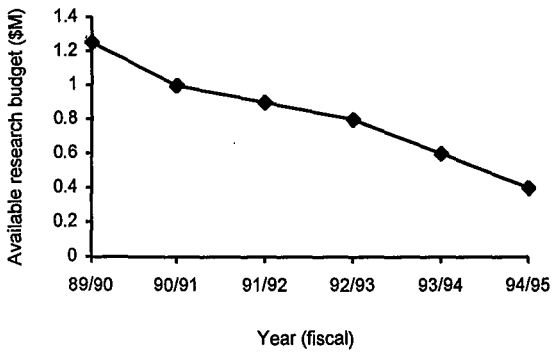


Figure 12
Available research budget from CF - six year trend

SID's dependence on external resources funds has increased from $0.5M to nearly $2.5M from 1989/90 to 1993/94 (see Fig 13). Well over half of this sum comes from the Federal Government.

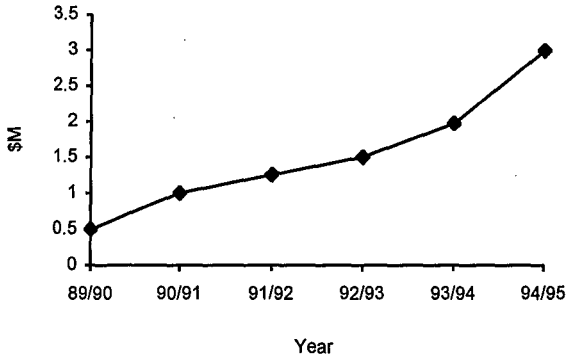
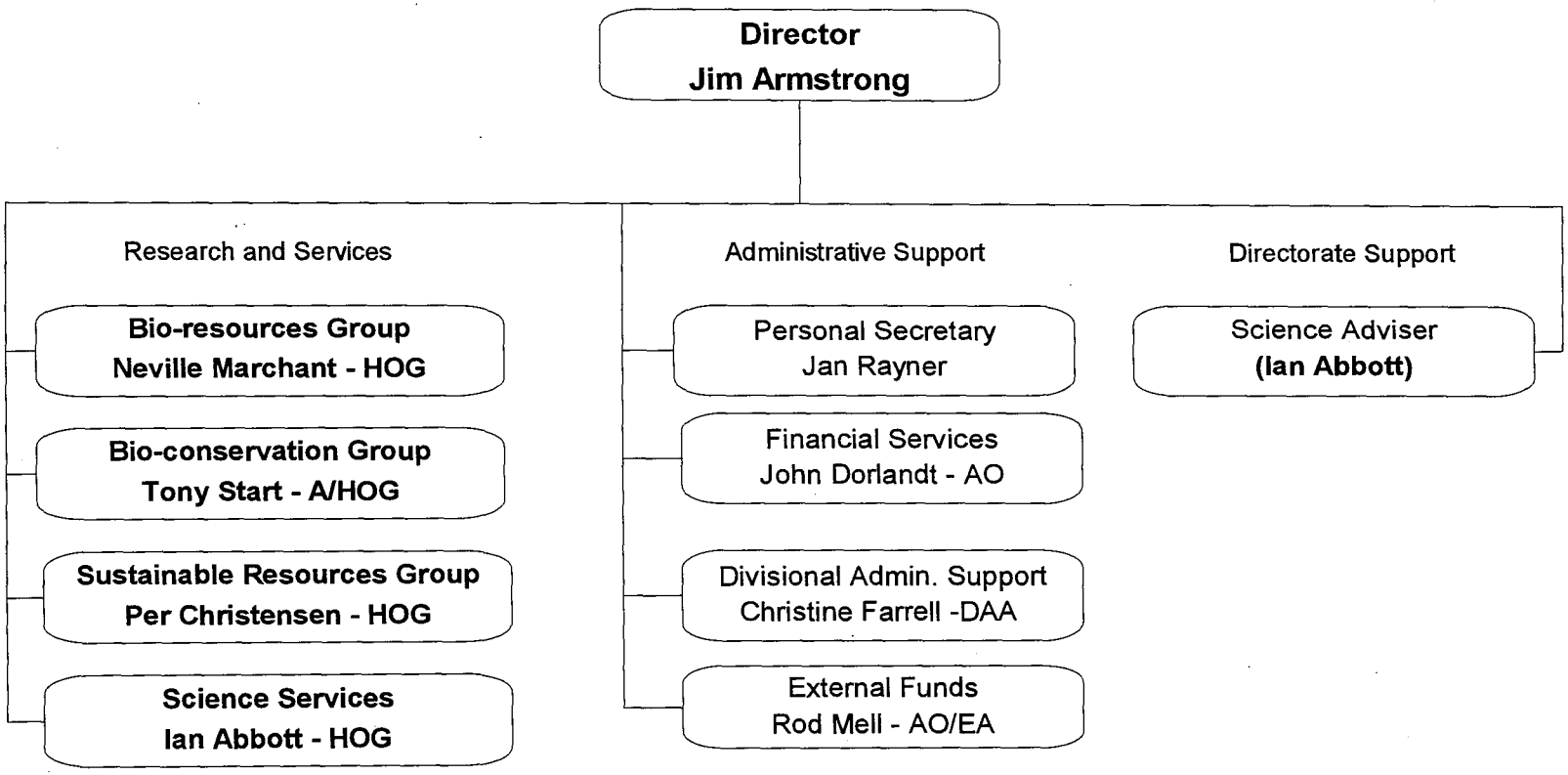


Figure 13
External (non-SID) funds won by SID scientists over 6 consecutive years

EXPENDITURE SUMMARY OF EXTERNAL GRANTS

SOURCE	1992/93	1993/94	1994/95	TOTAL
FEDERAL GOVERNMENT				
ANPWS/ANCA	1 065 858	1 166 875	1 827 158	4 059 891
Land & Water Resource RDC		80 301	252 815	333 116
ABRS	63 767	111 227	100 188	275 182
Vertebrate Biocontrol Co-operative Research Centre	96 155	39 525	130 461	266 141
Landcare		33 117	229 910	263 027
Dept Primary Industries & Energy		54 232	109 390	163 622
Rural Industries Research and Development Corporation	20 000	33 476	55 260	108 736
Australian Heritage Commission	40 909	35 539	740	77 188
CSIRO	3 082	22 862	28 816	54 760
Total	**1 289 771**	**1 577 154**	**2 734 738**	**5 601 663**
COMMERCIAL				
World Wildlife Fund for Nature	64 804	35 742	50 718	151 264
Tiwest	5 177	41 884	41 579	88 640
Land Corp		84 759		84 759
Towlshire	48 218	23 050		71 268
Meriwa		33 514	37 510	71 024
Alcoa	22 683	22 818	17 946	63 447
WAPET	25 867	22 580	6 547	54 994
Earth Sanctuary		21 711		21 711
Temwood Holdings		18 565		18 565
Various (all <$1K)	38 014	46 902	44 875	129 791
Total	**204 763**	**351 525**	**199 175**	**755 463**
STATE GOVERNMENT				
National Parks & Nature Conservation Authority	50 724	19 766	4 634	75 124
Main Roads Department			42 808	42 808
Dept Commerce & Trade		21 370		21 370
Land & Waterways Commission	11 244	1 392		12 636
WA Water Authority	3 552	5 083	9 731	18 366
Dept of Productivity and Labour Relations	6 823			6 823
Total	**72343**	**47 611**	**57 173**	**177 127**
GRAND TOTAL	**1 566 877**	**1 976 290**	**2 991 086**	**6 534 253**



Science and Information Division Organizational Structure

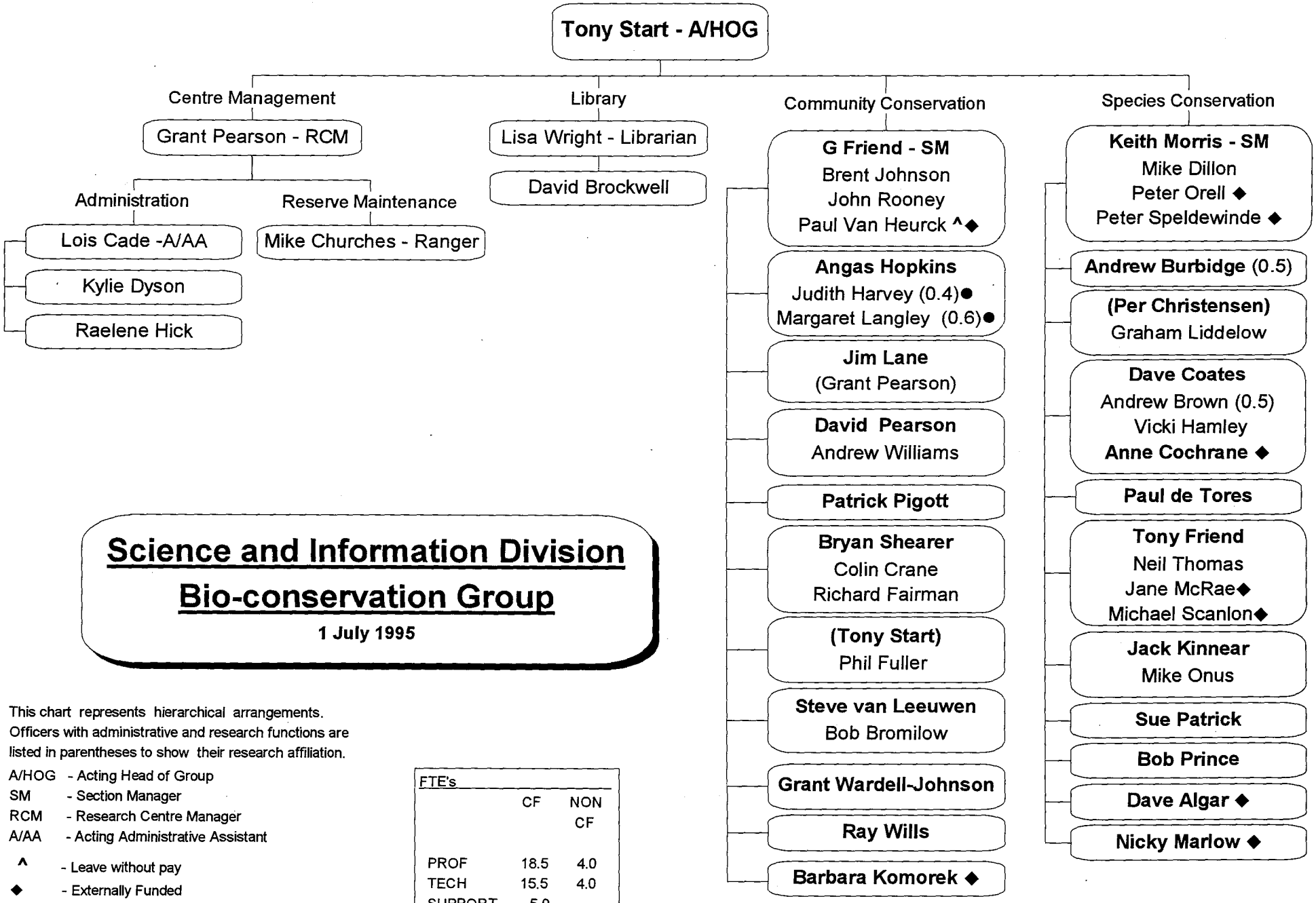
1 July 1995

DIVISIONAL FTE's	CF	NON CF
DIRECTORATE	5.0	
BIO-RESOURCES	25.3	
BIO-CONSERVATION	40.0	8.0
SUST- RESOURCES	38.6	1.0
SCIENCE SERVICES	11.0	0.6
TOTAL	119.9	9.6

This chart represents hierarchical arrangements. Officers with administrative and research functions are listed in parentheses to show their research affiliation.

HOG - Head of Group
A/HOG - Acting Head of Group
AO - Administrative Officer
AO/EA - Administrative Officer -External Accounts
DAA - Divisional Administrative Assistant
CRF - Consolidated Fund
FTE - Full Time Equivalent

DIRECTORATE FTE's	CF	NON CF
PROF	1.0	
TECH	.	
SUPPORT	4.0	
OTHER		
TOTAL	5.0	



Science and Information Division
Bio-conservation Group

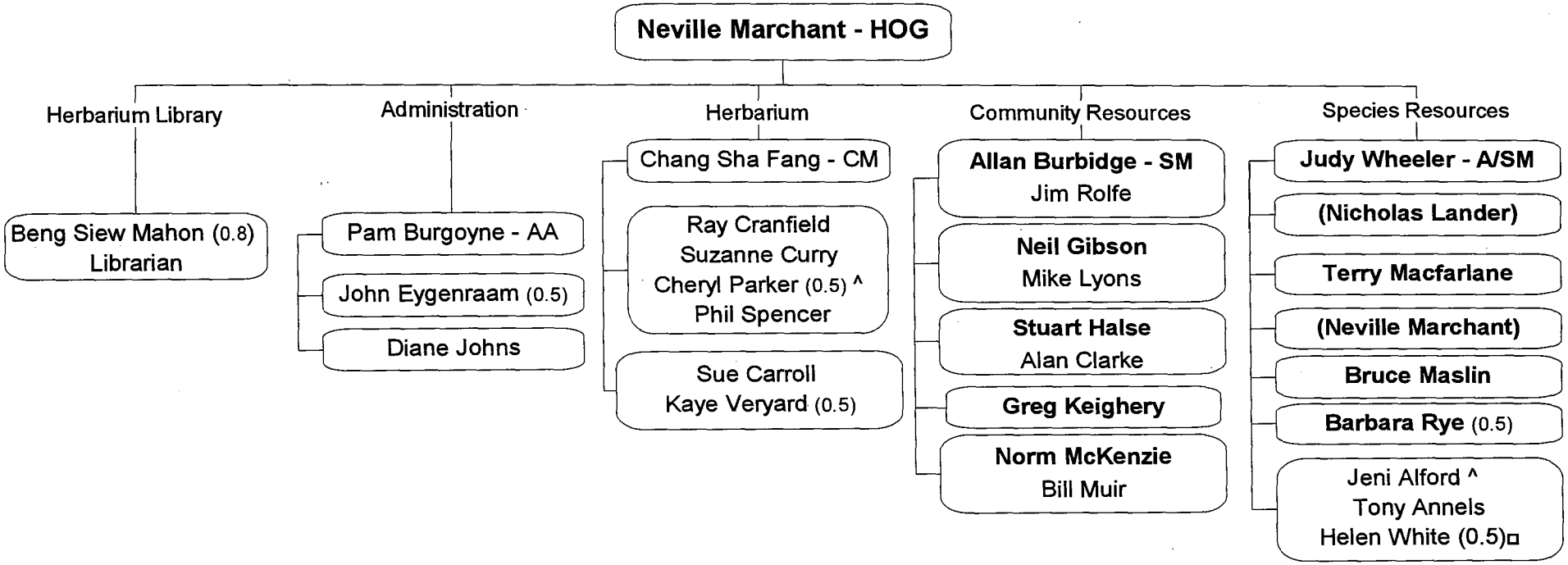
1 July 1995

This chart represents hierarchical arrangements.
Officers with administrative and research functions are listed in parentheses to show their research affiliation.

A/HOG - Acting Head of Group
SM - Section Manager
RCM - Research Centre Manager
A/AA - Acting Administrative Assistant
^ - Leave without pay
◆ - Externally Funded
● - Job Share
CF - Consolidated Fund
FTE - Full Time Equivalent

FTE's

	CF	NON CF
PROF	18.5	4.0
TECH	15.5	4.0
SUPPORT	5.0	
OTHER	1.0	
TOTAL	40.0	8.0



Science and Information Division

Bio-resources Group

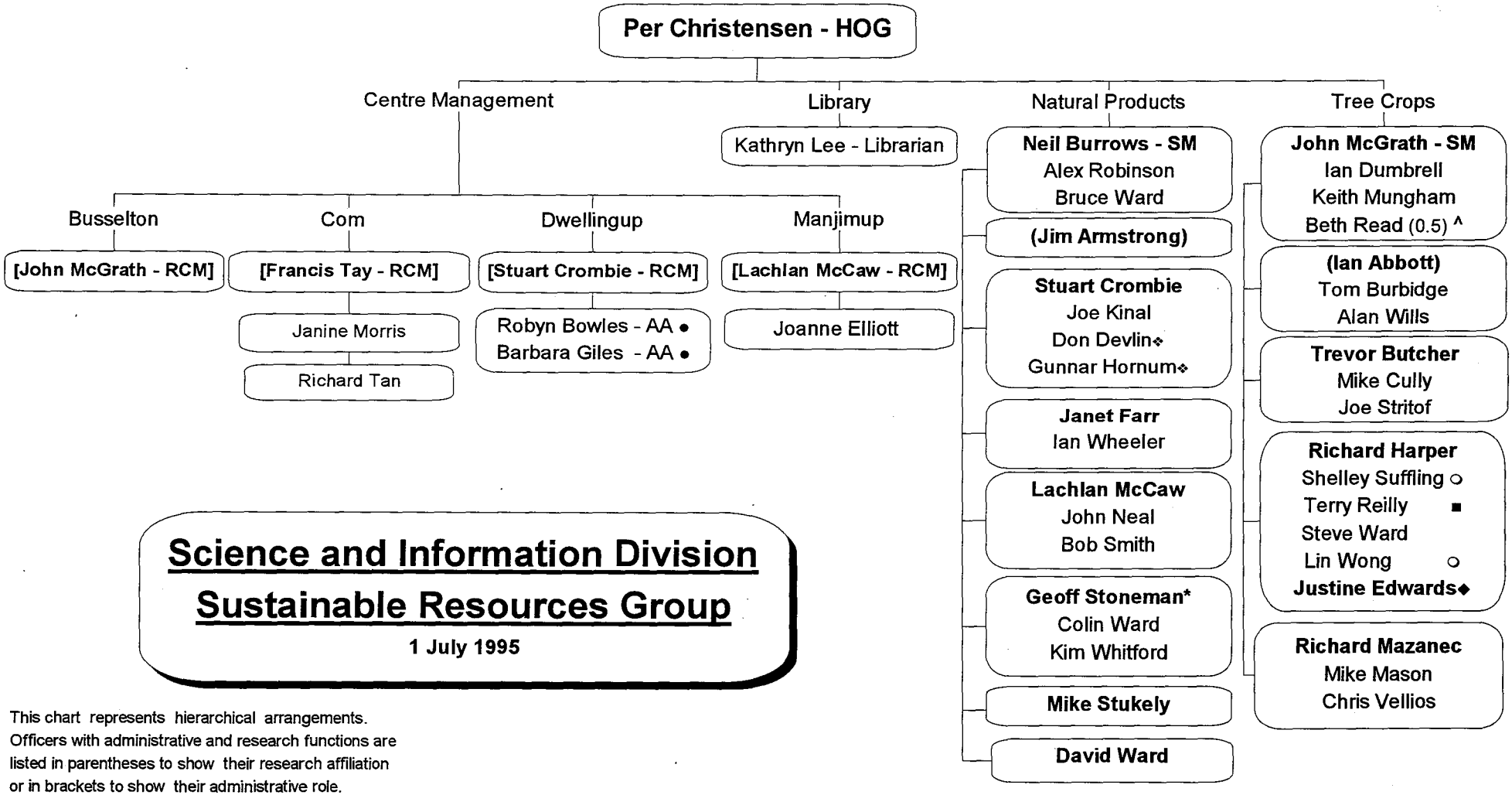
1 July 1995

This chart represents hierarchical arrangements. Officers with administrative and research functions are listed in parentheses to show their research affiliation.

HOG	- Head of Group
SM	- Section Manager
CM	- Collections Manager
AA	- Administrative Assistant
^	- Leave without pay
□	- Maternity Leave
CF	- Consolidated Fund
FTE	- Full Time Equivalent

FTE's

	CF	NON CF
PROF	9.5	
TECH	11.0	
SUPPORT	4.8	
TOTAL	25.3	



Science and Information Division
Sustainable Resources Group

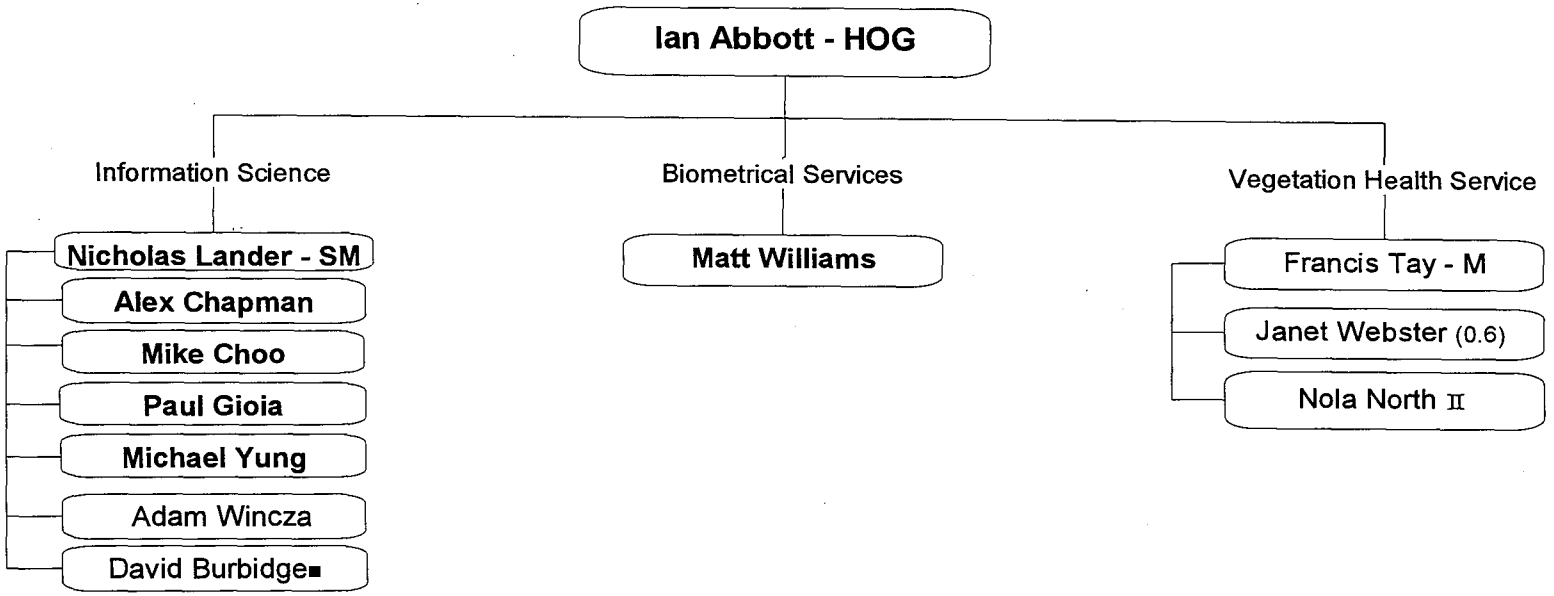
1 July 1995

This chart represents hierarchical arrangements. Officers with administrative and research functions are listed in parentheses to show their research affiliation or in brackets to show their administrative role.

HOG	- Head of Group
RCM	- Research Centre Manager
SM	- Section Manager
AA	- Administrative Assistant
^	- Leave without pay
❖	- Wages
◆	- Externally Funded
■	- CRF Funded (not SID)
○	- Laboratory
●	- Job Share
*	- Seconded
CRF	- Consolidated Revenue Fund
FTE	- Full Time Equivalent

FTE's

	CF	NON CF
PROF	11.0	1.0
TECH	20.6	
SUPPORT	5.0	
OTHER	2.0	
TOTAL	38.6	1.0



Science and Information Division
Science Services Group

1 July 1995

HOG - Head of Group
SM - Section Manager
M - Manager
II - Externally Funded 0.6 & CF Contract 0.4
■ - Consolidated Fund (SID)
CF - Consolidated Fund
FTE - Full Time Equivalent
^ - Leave without pay

FTE's	CF	NON CF
PROF	7.0	
TECH	3.0	0.6
SUPPORT	1.0	
OTHER		
TOTAL	11.0	0.6

STAFF IN SCIENCE AND INFORMATION DIVISION FUNDED FROM CONSOLIDATED REVENUE

(based on Management Charts dated 1.7.95)

	Professional	Other	Total
Directorate	1.0	4.0	5.0
Bio-resources Group	9.5	15.8	25.3
Bio-conservation Group	18.5	20.5	40.0
Sustainable Resources Group	11.0	27.6	38.6
Science Services Group	7.0	4.0	11.0
TOTAL	47.0	71.9	119.9

(The above information includes Job Share, Maternity Leave, Wages, CALM Funded and CF contract)

STAFF CHANGES

New appointments

P de Tores	from CALM (Harvey)	1992/93
A Hopkins	from Heritage Council of WA	1992/93
B Johnson	from CALM (Karratha)	1992/93
D Johns	from CALM (Mundaring)	1993/94
K Lee	from Department of Agriculture	1993/94
R Mell	from CALM (Engineering)	1993/94
J Morris	from CALM (Moora)	1994/95

Departures (transfer, promotion, redundancy and resignations)

Professional

B Koch	resigned	1992/93
K Kenneally	transferred to Science Publication Unit	1993/94
G Perry	redundancy	1993/94
P Wilson	retired	1993/94
P Hewitt	transferred to Albany District	1994/95
L Barbour	transferred to Plantations Group	1994/95
J Bartle	transferred to Plantations Group	1994/95
G Brennan	transferred to Forest Resources Group	1994/95
B Glossop	transferred to Forest Resources Group	1994/95
R Moore	transferred to Plantations Group	1994/95
G Siemon	transferred to Forest Resources Group	1994/95
G Stoneman	seconded to Crawley	1994/95
E Davison	resigned	1995/96

Technical & Clerical

I Alexander	transferred Manjimup District	1992/93
B Anza	redundancy	1993/94
D Burton	transferred Albany District	1992/93
S Dick	resigned	1993/94
J Ellender	transferred to Human Resources Branch	1993/94
P Heslewood	transferred to Human Resources Branch	1992/93
T Leftwich	retired	1993/94
M Lewis	transferred to Science Publication Unit	1993/94
I McPharlin	promoted to Bush Fires Board	1993/94
D Minarovic	resigned	1992/93
J Nicholson	transferred to Finance Branch	1992/93
C Portlock	transferred to Planning Branch	1992/93
W Roe	transferred to Wildlife Branch	1992/93
W Searle	transferred to Science Publication Unit	1993/94
E Vickery	resigned	1992/93
C Wilkinson	resigned	1994/95
P Beatty	transferred to Plantations Group	1994/95
T Birmingham	transferred to Plantations Group	1994/95
D Bishop	transferred to Forest Resources Group	1994/95
W Edgecombe	transferred to Plantations Group	1994/95
R Giles	transferred to Plantations Group	1994/95
G Godfrey	transferred to Plantations Group	1994/95
D Greep	transferred to Forest Resources Group	1994/95
W Hanks	resigned	1994/95
B Hingston	transferred to Plantations Group	1994/95
M Lathwell	resigned	1994/95
T Mitchell	transferred to Plantations Group	1994/95
D Nile	transferred to Plantations Group	1994/95
J Pitcher	transferred to Forest Resources Group	1994/95
J Winchcombe	transferred to Plantations Group	1994/95
Y Winchcombe	transferred to Forest Management Branch	1994/95

DURING THE TRIENNIUM THE FOLLOWING STAFF TRANSFERRED BETWEEN RESEARCH LOCATIONS:

Professional

I Abbott	Como to Crawley	1992/93
J Armstrong	Herbarium to Crawley	1992/93
N Burrows	Woodvale to Como	1992/93
E Davison	Como to Manjimup	1994/95
J Lane	Woodvale to Busselton	1994/95
T Macfarlane	Herbarium to Manjimup	1993/94
R Mazanec	Dwellingup to Como	1992/93
P Pigott	Narrogin to Herbarium	1992/93
B Shearer	Dwellingup to Como	1992/93

G Wardell-Johnson	Manjimup to Woodvale	1993/94
R Wills	Dwellingup to Herbarium	1993/94

Technical and Clerical

D Brockwell	Herbarium to Woodvale	1993/94
P Burgoyne	Manjimup to Herbarium	1993/94
J Dorlandt	Como to Herbarium	1992/93
W Hanks	Harvey to Herbarium	1992/93
M Mason	Dwellingup to Manjimup	1992/93
D Minarovic	Woodvale to Herbarium	1992/93
B Morgan	Dwellingup to Como	1992/93
J Rayner	Woodvale to Crawley	1992/93
P van Heurck	Como to Woodvale	1992/93
J Webster	Dwellingup to Como	1992/93
A Wincza	Dwellingup to Como	1992/93
H White	Manjimup to Herbarium	1993/94

Expertise of current scientific and other senior staff

Senior Management Team

Armstrong, Jim
BSc Agr, University of Sydney, PhD University of New South Wales. Twenty-four years research experience in plant systematics, pollination ecology, phytochemistry, plant biogeography and phylogeny. Current research interests are in higher taxon cladistic studies, pattern and process in biotic diversity, sustainable conservation and biota-based drug discovery.

Abbott, Ian
BSc (Hons), University of Sydney 1968; PhD, Monash University 1972; DSc, University of Western Australia 1992.
Areas of expertise and past research experience: Biogeography of species on islands, with special reference to rates of immigration and extinction; morphological variation within and between populations of birds on islands; responses of soil invertebrates to land use, climate and fire; ecology of the major tree species in the northern jarrah forest of Western Australia; and the ecology of the pest insect Jarrah leafminer in relation to forest management. More than 120 scientific papers published.

Christensen, Per
Dip For (Kenya), BSc (Hons) Rhodes University, PhD Zoology, University of Western Australia. 25 years research experience, Head of Forest Science Group. Areas of expertise: Forest ecology, pine and hardwood silviculture and forest pathology.

Marchant, Neville
BSc(Hons), University of Western Australia; PhD, University of Cambridge. 23 years research experience in plant taxonomy and a broad knowledge of the vegetation of Western Australia. Expertise includes species and ecosystem conservation, inventory of potentially useful native flora, taxonomic studies and preparation of user-friendly flora handbooks.

Start, Antony
BSc (Hons), Aberdeen, Degree in Zoology. PhD. Aberdeen, thesis on the biology of nectar feeding bats and the plants they pollinate. Current expertise and research interests are in bat ecology, fire ecology in arid zones, and mistletoes.

Algar, David
BAgricSc with First Class Honours from the Faculty of Agriculture and Forestry at Melbourne University, MAgricSc from the same University and PhD in zoology from the University of Western Australia.
Areas of expertise: fox control, feral cat control strategies.

Brennan, Gary
BSc (For) Australian National University. Areas of expertise and past research experience: Nine years experience sawmilling, timber drying, timber preservation, and silviculture and wood utilization interaction.

Bunny, Felicity
BSc (Biology), Post Graduate Diploma Env. Impact Assessment, Murdoch University 1991. Training in soil microbiology and plant pathology. Expertise in forest plant water relations and host/pathogen interactions.

Burbidge, Andrew
BSc (Hons), University of Western Australia 1963; PhD., University of Western Australia 1967.
Areas of expertise and past research experience: Conservation of threatened species and ecosystems; conservation of mammals and reptiles; biogeographic survey of Kimberley; deserts and Eastern Goldfields; island biogeography; evaluation of conservation reserve systems; Aboriginal oral history relevant to mammals and fire ecology; status of crocodiles; conservation of seabirds. Author or co-author of 85 scientific papers and reports, 41 educational or other short articles and editor or co-editor of 12 books, conference proceedings or other major publications.

Burbidge, Allan
BSc (Hons), Flinders. Degree in Biology: Honours dissertation on breeding systems in the *Casuarina distyla* group. PhD (UWA) thesis on breeding systems in triggerplants (*Stylidium*).

Burrows, Neil
BSc (For), Australian National University. 15 years research experience in bushfire behaviour and ecological effects. Developed fire behaviour and impact prediction models, and prescribed fires in woodlands and hummock grasslands.

Butcher, Trevor
BSc, Australian National University and MSc University of Western Australia, 1987 on genetic variation of *Pinus radiata* and *Phytophthora cinnamomi* disease resistance. 25 years research experience with the breeding of *Pinus pinaster, P. radiata* and more recently, *Eucalyptus globulus*.

Chapman, Alex
BSc., University of New England, Grad. Dip., Computer Science Murdoch University. Areas of expertise and past research experience: Taxonomy of *Leucopogon* and *Acacia* and the systematics of the Epacridaceae; herbarium information systems design and management, focusing on specimen and nomenclatural databases; computer applications in taxonomy, especially interactive keys and descriptive databases; use of GIS in current *Phytophthora* research management and modelling.

Choo, Mike
MSc, University of Technology, Loughborough, U.K. Areas of expertise and past research experience: 9 years in scientific information management and analysis (and a further 8 years in the commercial sector); Database design concepts and methodology; Relational systems; modern technological research tools, and the application of current technology to research.

Coates, David
PhD, University of Western Australia 1979. 18 years research experience in population genetics and genetic systems, cytogenetics, evolutionary biology and biosystematics, and population ecology. More recently (over the last 8 years) research has focused on conservation biology particularly conservation genetics of rare and endangered plant species and the development of management strategies for their *in situ* and *ex situ* conservation. Other research has involved studies on the Australian sea lion and the skink *Carlia johnstonei*.

Crombie, Stuart
PhD, University of Glasgow 1983 on differences in species drought tolerance relating to xylem (sapwood) structure, BSc, University of Qld 1978, Post-Graduate Diploma of Environmental Impact Assessment, Murdoch University 1991. Specialist in measuring tree water status and water use and relating tree vigour and growth to water status and dieback damage. Major work since has been documenting the relationship between *P. cinnamomi* infection and dieback symptom development in jarrah, including loss of water using capacity and growth.

Davison, Elaine
BSc (Hons) Botany University of Bristol 1963; PhD University of Bristol 1967. Areas of expertise and past research experience: plant pathology, especially the pathology of woody plants. Approach has been as a generalist, considering all aspects of the health of seedlings, saplings and mature trees. Many of these investigations have been of specific symptoms caused by fungal pathogens, but have also included studies of how site conditions affect plant physiology, and how this in turn affects invasion by particular pathogens. Understanding how site and weather conditions affect the ability of woody plants to restrict fungal invasion allows predictions of potentially difficult sites for tree survival and growth.

de Tores, Paul
BSc and Postgraduate Diploma in Natural Resources, University of New England, Armidale NSW. Six years experience in natural resource management and planning. Experience in mammal survey techniques and radio-telemetry.

Dorlandt, John
28 years experience in financial systems and controls, staff and branch administration and management of CALM's estate.
Current major project includes the design and restructure of the Science and Information Division's accounts within CALM for both CRF and Trust Accounts. Co-ordinates financial services for Science and Information Division.

Farr, Janet
BAgSc (Hons) PhD in entomology, University of Adelaide, on the performance of *Uraba lugens* Walker in relation to nitrogen and phenolics present in its food. Expertise and interests in chemical analysis of eucalypt foliage, insect/host plant interrelations, native forest entomology, American five spined bark beetle (*Ips grandicollis*) in pine.

Friend, Gordon
PhD, Melbourne University 1978 on the impact of exotic *Pinus radiata* plantations on vegetation and small vertebrates. 20 years research experience on small vertebrate and invertebrate communities and their response to disturbance (eg. exotic plantation establishment, introduced tropical herbivores, fire and logging), sampling strategies and trapping methodology, and fauna/habitat relationships.

Friend, James (Tony)
BSc (Hons), PhD in Zoology, University of Tasmania. 12 years experience in conservation biology of threatened mammals in WA, including studies of species biology, habitat utilisation, population dynamics. Expertise in mammal study techniques, radio-tracking techniques and analysis, taxonomy of terrestrial amphipods

Gibson, Neil
PhD in botany, University of Tasmania 1988. Ten years research experience in community ecology, single species ecology and vegetation survey.

Gioia, Paul
B Eng (Elec Eng), Curtin University. 12 years experience in scientific information collection and management, particularly biological database methodology, the use of geographic information systems for biological conservation and management applications, electronic data communications and network installation and administration in a scientific corporate data context. Developed a coding system for taxa that handles revisions and maintains taxonomic history.

Glossop, Brett
BSc, University of Western Australia. Major interest in timber drying research and development. Biometrical and computing background. Major involvement in developing kiln control systems for the CALM Dryers, and improved drying schedules for WA grown timber.

Halse, Stuart
BSc (Hons), University of Western Australia; PhD, University of the Witwatersrand. Areas of expertise include waterbirds, aquatic invertebrates, wetland ecology and seabirds.

Harper, Richard
BSc (Agric) Hons, University of Western Australia 12 years experience in research and extension of soil and land management information. Research interests centre on understanding the nature and distribution of soils, and how these factors relate to land management (plant response, land degradation, soil amelioration).

Hopkins, Angas
BSc (Hons), University of Queensland. Initial research on ecology of mangroves before transferring to Western Australia in 1975 to work on terrestrial ecosystems. Focus of current research on management issues including fire and rehabilitation/reconstruction following detailed ecological survey of selected, intensive study sites in the Northern Kwongan, the central wheatbelt and along the south coast. Other interests include modelling, island biology and integration of research and management, particularly through monitoring.

Keighery, Gregory
BSc (Hons), University of Western Australia. Areas of expertise and past research experience: Cytolog of plants, breeding systems of WA Flora, pollination of WA Flora, Taxonomy of WA Lilies, selected genera of Myrtaceae, Apiaceae and Juncaginaceae, environmental weeds of WA, biological survey.

Kinnear, Jack
BSc, (Alberta); MSc (British Columbia); PhD (WA). Areas of expertise and past research experience: Fishery biology management; fish physiology and endocrinology; marsupial physiology; macropodid nutrition; microbiology.

Komorek, Barbara
BAgricSc, Melbourne University, 1986 majoring in crop physiology, plant pathology and soil science. Research experience in the area of root function, plant water relations, soil chemistry and physics as well as environmental studies (soil amendments).

Lander, Nicholas
BSc, University of Sydney; Graduate Diploma of Public Sector Management, Curtin University of Technology. Expertise and research interests: 23 years in plant taxonomy, notably Asteraceae, Celastraceae and Malvaceae; current focus on taxonomy of Australian *Olearia* (Asteraceae), and computing applications to descriptive taxonomy. Australian Botanical Liaison Botanist 1984-5.

Lane, Jim
BSc, University of Western Australia. Area of expertise and past research experience: Management of nature reserves (particularly wetlands), management of recreational waterfowl hunting, waterbird population surveys, shorebird banding studies, wetland surveys (flora and fauna inventory). Current emphasis is identification of major wetland management issues in WA; initiation, support and conduct of relevant research, and provision of management guidance.

Macfarlane, Terry
BSc (Hons), University of Western Australia, PhD, Australian National University. Expertise in plant taxonomy. Previous work has included an important contribution to the classification of grasses, the development of database approaches in taxonomy, and authorship of parts of Floras including the Flora of Australia.

Maslin, Bruce
BSc (1967), MSc (1977), University of Western Australia. 25 years research experience dealing with systematics of *Acacia*. Appointed Australian Botanical Liaison Officer for 1977-78.

Marlow, Nicky
PhD, University of NSW on the ecology of red foxes (*Vulpes vulpes*) in the arid zone of NSW.

Mazanec, Richard
BScFor, Australian National University. Areas of expertise and experience: Quantitative genetic variation in forest eucalypts endemic to WA and in eucalypt species for use in plantations and farmland rehabilitation.

McCaw, Lachlan
BForSci, University of Melbourne; currently enrolled as external MSc candidate at the University of NSW ADFA campus studying behaviour of fires in mallee-heath shrubland. 12 years research experience into the application and effects of fire in forests, woodlands and shrublands.

McGrath, John
BSc Agric (Hons), PhD University of Western Australia 1983 on the zinc nutrition of *P. radiata* seedlings. 16 years research experience in the nutrition and silviculture of softwood plantations in WA, with the focus on diagnosing nutrient deficiencies and determining the most economic fertilization strategies.

McKenzie, Norman
MSc (Zoology), Monash University. Expertise: animal ecology; quantitative approaches to ecological survey and reserve system design; co-ordinating regional surveys. Research interests: biogeography of Australian mammals, reptiles, land snails and earthworms; patterns in assemblage composition; mammal taxonomy. Most notable scientific accomplishment to date: the "Kimberley Rainforests" study published as a book by Surrey Beatty and Sons.

Moore, Richard
BSc (For), Australian National University, 1974. 12 years experience in agroforestry R&D; with focus on fitting multiple tree crops into farming systems and determining production levels for tree products and developing management methods.

Morris, Keith
MSc, University of Western Australia 1981 on the ecophysiology of native Australian rodents. Twelve years research and management experience on island fauna and threatened mammal populations. Developed programs to eradicate introduced mammals, particularly the Black Rat, from island nature reserves in the presence of non-target species.

Patrick, Susan
BSc in Botany, University of Leicester, 1966. Areas of expertise, Flora Conservation and surveys, Rare and Threatened Flora in WA, past experience in identification of *Cannabis*, toxic, naturalized and general plant taxa, botanical illustration.

Pearson, David
B Nat Res (Hons), University of New England; G Dip Aboriginal Studies, South Australian College of Advanced Education. Expertise and research interests in desert lizard and small mammal communities and their responses to fire, traditional Aboriginal fire practices in the Gibson and Great Victoria Deserts, ethno-biological data collection and surveys for rare desert fauna.

Perry, Gillian
BSc (Hons) and MSc in Botany, University of Western Australia. Previous research focused on the nomenclature and taxonomy of the naturalized flora of Western Australia.

Pigott, Patrick
BAppSc (Biol), Western Australian Institute of Technology, and MSc, University of Western Australia. Ten years research and practical experience in plant ecology and bushland regeneration, particularly eucalypt and banksia woodlands on the Perth coastal plain and southern wheatbelt. Expertise in the dynamics of these plant community types with emphasis on the impacts of anthropogenic disturbance, including altered fire regimes, grazing, clearing and

weed invasions. Other research has examined the efficacy of the government's remnant vegetation fencing scheme and ways of improving the information required from farmers to qualify them for subsidies.

Prince, Robert
PhD in Zoology, UWA 1976, following BSc (Agric) Hons UWA.
Areas of expertise and past research experience: Management of kangaroo populations and associated land management, exploitation of marine wildlife by indigenous people, dugongs, marine turtles and seagrasses. General marine management issues.

Rye, Barbara
PhD, University of Western Australia 1980 on chromosome numbers, reproductive biology and evolution in the Myrtaceae. Other main areas of experience: flora writing for regional and national floras, taxonomic revisions and reviews, surveys of rare flora.

Shearer, Bryan
PhD in plant pathology, University of Minnesota, 1975. 12 years research experience in plant disease epidemiology and resistance of cereals to leaf spot pathogens; and 14 years experience in impact and control of *Phytophthora* species, *Armillaria luteobubalina* and canker fungi in native communities.

Siemon, Graeme
PhD, Australian National University, BSc (For) Hons, Australian National University. Twenty years experience in general timber utilization research, in areas including wood properties, sawmilling, timber drying, timber preservation. Major involvement in refereeing and editing scientific papers, research and development, administration, and technical enquiries.

Stoneman, Geoff
BSc (For), Australian National University, PhD. Murdoch University. 13 years research experience on the silviculture, hydrology and physiology of jarrah forest, particularly the effects of thinning and regeneration.

Stukely, Mike
BSc (Agric)(Hons), University of Western Australia, 1974. 16 years experience in research on aspects of forest pathology and silviculture in Forestry Dept of WA and CALM. Expertise in identification of locally-occurring *Phytophthora* species; Manager of Dieback Disease Detection Service.

Turner, Stephanie
PhD in Marine Ecology, University of St Andrews (UK) 1988. Research experience in the ecology of temperate hard substratum and coral reef assemblages, in particular the early life history and recruitment dynamics of marine invertebrates.

van Leeuwen, Stephen
BA in Biology and Geography, Western Australian Institute of Technology, Grad Dip Nat Res, Western Australian Institute of Technology. Areas of expertise and research interest: flora conservation, arid zone flora, arid zone ecology, fire ecology, pollination ecology, botanical surveys, plant population biology. Notable scientific accomplishments: Western Australia's Endangered Flora (Hopper, van Leeuwen, Brown and Patrick, 1990), Nature Conservation, Landscape and Recreational values of the Lesueur area (Burbidge, Hopper and van Leeuwen, 1990).

Ward, David
BAppSc (Maths and Biology), Western Australian Institute of Technology, Master of Human Ecology [Brussels]. Interested in maths, biology, ecology, geography, management and humans. 20 years experience in biometrics. Qualified in human ecology, which bridges natural and social sciences.

Wardell-Johnson, Grant
BSc (For), Australian National University, MSc (Oxford), currently part time PhD project at University of Western Australia on the ecology and biogeography of four locally endemic forest eucalypts. 12 years research experience on forest disturbance ecology (impacts of logging/fire on birds, terrestrial vertebrates and vascular plants) and forest biogeography (vascular plants, terrestrial vertebrates).

Wheeler, Judy
BSc, University of Durham (UK). 15 years experience in plant taxonomy with particular expertise in writing and editing regional floras; also taxonomic studies in the genus *Hibbertia*.

Wills, Raymond
BSc (Hons), PhD, University of Western Australia. Over 10 years of research experience in terrestrial plant ecology, particularly with regard to the impact of disturbances such as fire and disease, and interest in phenology, pollination ecology, mycology, and climate change. Research, conducted in a range of plant communities, has established a Departmental data base on the susceptibility of native plant species, particularly rare, threatened and poorly known flora, to plant pathogens. This information has been used in management plans, and to target vulnerable species for seed collection and micropropagation in a project to preserve genetic resources.

Williams, Matthew
BSc (Mathematics) and BSc (Honours, Botany - analysis of biological time series data), University of Western Australia; Grad Dip Computing Studies, Murdoch University. Divisional Biometrician.

Yung, Michael
PhD in physics, University of WA 1978 - on molecular bonding by x-ray diffraction. Thirteen years research in the WA Public Service; published in groundwater modelling. Research covered water supply engineering, CAD in architecture and economic time series. Three years experience in wildlife research support, with publications in bird population management.

Representation of science staff on committees

Internal	External representing CALM	External Non-Departmental
IAN ABBOTT		
CALMScience Editorial Advisory Board	Forest Monitoring and Research Committee	Journal of Australian Entomological Society - member of editorial board
Science and Information Management Council		
WA Museum/CALM Coordinating Committee		
JIM ARMSTRONG		
Assessment Panel for funding under the Australian Nature Conservation Agency's Endangered Species Program, Feral Pests Program and National Reserve System Co-operative Program (Assessor)	ANZECC Task Force - Commonwealth/ State Working Group - Access to Australia's Genetic Resources	Plants Committee, United Nation's Convention on International Trade in Endangered Species of Wild Fauna and Fauna (CITES) (Chair)
Beekeepers Consultative Committee	Australian Forestry Council's Research Working Group 10 (Wildlife and Habitat Management) (Co-ordinator)	CITES Plants Committee (Oceania Representative)
Classification Review Committee	CSIRO Centre for Mediterranean Agricultural Research (Director, on Board of Directors)	CITES Timber Working Group (Chair)
Corporate Executive	Co-operative Research Centre for Biological Control of Vertebrate Pest Populations (Director, on Board of Directors)	Immunogenetics Research Foundation (Director, on Board of Directors)
Endangered Flora Consultative Committee	Curtin University, Board of Study and Advisory Committee for the School of Environmental Biology	'National Forensic Resource Register' established by the National Police Research Unit (Registrant)
Executive IT Committee	Forest Monitoring and Research Committee (Chair)	Protection of Movable Cultural Heritage Act 1986 (Expert Examiner)
Feral Pest Management Committee	Standing Committee on Forestry's Research Priorities and Coordination Committee	IUCN/SSC Australasian Plant Specialist Group
Finance & Budget Committee	University of Western Australia Department of Geography's Visiting Committee	IUCN/SSC Medicinal Plants Specialist Group
Introduced Predator Control Committee	WA Research Steering Committee for Land Use and Water Supply	
Science and Information Management Council		
Science Publications Committee		
Sponsorship Steering Committee		
Threatened Species and Communities Management Committee		
WA Museum/CALM Coordinating Committee (Chair)		
WURC Policy Panel		
JOHN BARTLE		
VATPAS	Integrated Catchment Management Policy Group (Deputy)	

Internal	External representing CALM	External Non-Departmental
GARY BRENNAN		
	Australasian Wood Preservation Committee	
	Collie Land Conservation District Committee	
ALLAN BURBIDGE		
Nambung-Wannagarren-Nilgen-Southern Beekeepers Reserve Management Planning Team	Gouldian Finch Recovery Team	Coordinating committee for the first Southern Hemisphere Ornithological Congress
Noisy Scrub-bird Recovery Team	Malleefowl Recovery Team	Parrot Conservation Association advisory group to Birdlife International
SID Bio-resources Management Team		
Western Bristlebird Recovery Team		
Woodvale Research Centre Management Team		
Threatened Fauna Scientific Advisory Committee		
ANDREW BURBIDGE		
Chuditch Recovery Team	WA Threatened Species and Communities Consultative Committee (Chair)	Endangered Species Advisory Committee; and Endangered Species Scientific Sub-committee (Chair)
Endangered Flora Consultative Committee	ANZECC Task Force (Endangered Fauna Network)	IUCN/SSC Australasian Marsupials and Monotremes Specialist Group (Chair)
IUCN Species Survival Commission's Australia-		IUCN/SSC Reintroduction Specialist Group
Introduced Predator Control Committee		IUCN/SSC Tortoise and Freshwater Turtle Specialist Group
Lancelin Island Skink Recovery Team		Mala Recovery Team Northern Territory
Noisy Scrub-bird Recovery Team		
Numbat Recovery Team		
Orange-bellied and White-bellied Frogs Recovery Team		
Shark Bay Mouse Recovery Team		
Sponsorship Steering Committee		
Thevenard Island Mouse Recovery Team		
Threatened Fauna Scientific Advisory Committee		
WA Museum/CALM Coordinating Committee		
Western Swamp Tortoise Recovery Team (Chair)		
Woylie Recovery Team		
Western Bristlebird Recovery Team		

Internal	External representing CALM	External Non-Departmental
NEIL BURROWS		
SID Sustainable Resources Management Team	Australian Forestry Council's Research Working Group 6 (Fire Management)	IUCN/SSC Re-introduction Specialist Group
Kingston Project Leader	WA Bush Fires Board	
Project Eden		
TREVOR BUTCHER		
Glasshouse and Shadehouse Users Committee	Australian Forestry Council's Research Working Group - Forest Genetics Technical Committee - Gnangara Mound Recharge	
	Southern Tree Breeding Association	
ALEX CHAPMAN		
WAHERB Standards Committee		
WACENSUS Standards Committee		
MIKE CHOO		
Woodvale Management Team		
PER CHRISTENSEN		
Como Joint Consultative Committee	CSIRO Forest Research Priorities Committee WA	
Como Library Committee		
Forest Resources Policy Panel		
Project Eden		
Science and Information Management Council		
Scientific Publications Committee		
Sustainable Resources Group (Chair)		
Sustainable Resources Library Committee		
WURC Policy Panel		
DAVID COATES		
Endangered Flora Consultative Committee	Floriculture Industry Advisory Committee	Genetics Society of Australia (Committee)
	Australian Network for Plant Conservation Working Group for a National Germ Plasm Strategy	
STUART CROMBIE		
Como Library Committee		

Internal	External representing CALM	External Non-Departmental
ELAINE DAVISON		
Como Library Committee	Australian Forestry Council's Research Working Group 7 (Forest Pathology)	Vice-President Australasian Plant Pathology Society
JANET FARR		
Manjimup Joint Consultative Committee	Forest Research Group Australian Forestry Council's Research Working Group 8 ((Forest Entomology), Newsletter editor	
GORDON FRIEND		
Sustainable Jarrah Silviculture Research Committee SID Bio-conservation Management Team	Australian Forestry Council's Research Working Group 10 (Wildlife and Habitat Management)	Conservation Committee Australian Entomological Society Edith Cowan University - Biological and Physical Sciences Consultative Committee
TONY FRIEND		
Animal Experimentation Ethics Committee Dryandra State Forest Planning Team Threatened Fauna Scientific Advisory Committee	Numbat Breeding Management Advisory Committee	AMMSG Australian Marsupial & Monotreme Specialist Group Editorial Advisory Committee *Wildlife Research* IUCN/SSC: Re-introduction Specialist Group (Australasian Section Chair) Captive Breeding Specialist Group
NEIL GIBSON		
Northern Forest Rare Flora Recovery Team Lesueur National Park Management Team	ANCA Grassland Ecology Program Working Group	
PAUL GIOIA		
WACENSUS Standards Committee		
BRETT GLOSSOP		
Wood Utilisation Research Progress Meetings	Joint Timber Seasoning Committee (Australian) Australian Forests and Lands' Promotion/design meetings on solar kilns in other countries	TAFE Kiln Operator's Course
STUART HALSE		
Esperance Lakes Management Planning Team Lake Toolibin Recovery Plan Technical Advisory Group	Mosquito Control Review Committee Water Quality Sub-committee of the State Surface Water Co-ordinating Committee	TEE Biology Syllabus Committee Intecol Conference 1996 Organising Committee

Internal	External representing CALM	External Non-Departmental
	South Jandakot Environmental Monitoring Program - Technical Review Committee	
	Parrot Pest Research Panel	
RICHARD HARPER		
Como Joint Consultative Committee	Australian Forestry Council's Research Working Group 3 (Soils and Nutrition)	Soil and Water Conservation Association Australia (Inc) WA Branch
	Kent River Catchment Technical Committee	Australian Society of Soil Science (Inc) President WA Branch
ANGAS HOPKINS		
Advisory Committee for the Threatened Ecological Communities Project		
GREG KEIGHERY		
		ANZECC Weeds of Conservation Concern Network
		ANZECC Taskforce on Weeds of Conservation Concern
KEVIN KENNEALLY		
Nuytsia Editorial Board	Biological Surveys Committee	WA Gould League (Inc)
	International Botanical Gardens Conservation Congress Committee	Kimberley Society (Inc)
		Australian Council of Gould Leagues (Inc)
		Natural Environment Evaluation Panel, Australian Heritage Commission
BARBARA KOMOREK		
Como Joint Consultative Committee		
NICHOLAS LANDER		
IT Executive Committee		
IT Sub-committee		
Nuytsia Editorial Board		
JIM LANE		
Busselton Wetlands Conservation Plan Project Team	ANZECC Wetlands Network	
	ANZECC Migratory Species Network	
Perup-Muir Management Plan Project Team	ANZECC Task Force on Alternatives to Lead Shot in Hunting	

Internal	External representing CALM	External Non-Departmental
	Aquatic Ecosystems Sub-committee of Land and Water Research Steering Committee (Chairman)	
	Peel Harvey (Dawesville Channel) Monitoring Senior Officers Committee	
	Waterwatch Steering Committee	
	Yalgorup Lakes Research Project Steering Committee (WAWA)	
MARIANNE LEWIS		
CALMScience Editorial Board		
TERRY MACFARLANE		
Nuytsia Editorial Board		
Southern Forest Region Threatened Flora Recovery Team		
NEVILLE MARCHANT		
Herbarium Curation Committee		Coordinating Secretary, Botany 2000-Asia Network - Regional adviser for south and south east Asia
Herbarium Joint Consultative Committee		United Nations Educational and Scientific and Cultural Organisation (UNESCO)
Herbarium Library Management Team		Member, Asian Coordinating Group for Chemistry (ACGC)
Nuytsia Editorial Board		Editorial Board, Asian Co-ordinating Group, Chemical Publication
SID Bio-resources Management Team		Asian Symposium on Medicinal Plants and Spices (ASOMPS), Advisory Board
Science and Information Management Council		Adviser, The International Foundation for Science (IFS)
WA Museum/CALM Coordinating Committee		Industry Advisory Committee, Murdoch University
		Council of Heads of Australian Herbaria
BRUCE MASLIN		
WAHERB Standards Committee		
JOHN MCGRATH		
SID Sustainable Resources Management Team	Australian Forestry Council's Research Working Group 3 (Forests, Soils and Nutrition) (Chair)	

Internal	External representing CALM	External Non-Departmental
RICHARD MAZANEC		
	Australian Forestry Council's Research Working Group 1 (Forests Genetics)	
LACHLAN MCCAW		
Stirling Range/Porongurup Range Planning Team	MCFFA Research Working Group 6 (Fire Management)	
	MCFFA Research Working for Silviculture of Native Forests	
NORM MCKENZIE		
Conservation Lands Acquisition Committee	ANCA Interim Biogeographic Regionalisation Working Group	
CALM Prioritising Committee for National Reserve System Co-operative Program applications	National Forests Policy Implementation Reserve Criteria Working Group	
CALM Prioritising Committee for National Estate Grants Program applications	World Bank GEF Rapid Biodiversity Assessment Committee	
RICHARD MOORE		
	WA Agroforestry Working Group	International Tree Crops Institute (committee member)
	Australian Forestry Council's Research Working Group 11 (National Agroforestry Working Group)	
KEITH MORRIS		
Animal Experimentation Ethics Committee (Secretary)	Animal Welfare Advisory Council - Department Local Government	IUCN/SSC: Rodent Specialist Group, Captive Breeding Specialist Group
Chuditch Recovery Team (Chair)	Cat Control Advisory Board - Department Local Government	Reintroduction Specialist Group, Australian Marsupial and Monotreme Specialist Group
SID Bio-conservation Management Team	CRC Vertebrate Pest Control (Deputy)	
Shark Bay Mouse Recovery Team		
Thevenard Island Mouse Recovery Team		
Woylie Recovery Team		
SUSAN PATRICK		
Endangered Flora Consultative Committee		
Narrogin District Rare Flora Management Program		
Geraldton District Rare Flora Management Program		
Moora District Rare Flora Management Program		
Scientific Ranking Panel		

Internal	External representing CALM	External Non-Departmental
DAVID PEARSON		
Woodvale Joint Consultative Committee	Lancelin Island Recovery Team Mulgara Recovery Team	Treasurer, Australian Rangeland Society
GILLIAN PERRY		
Herbarium Curation Committee		
PATRICK PIGOTT		
Herbarium Management Team Herbarium Joint Consultative Committee Herbarium Library Management Team	Technical Sub-committee of the State Weeds Strategy Committee	
BOB PRINCE		
	ANZECC Working Groups - Sea Turtles and Dugongs	IUCN/SSC: Sirenia Specialist Group Marine Turtles Specialist Group
BARBARA RYE		
Herbarium Library Management Team *Nuytsia* Editorial Board		
GRAEME SIEMON		
Como Library Committee WURC Policy Panel	Forest Industries Federation (WA) Research Committee Standards Australia State Committee Review for Australian Agricultural and Veterinary Chemicals Council	
TONY START		
Bio-conservation Management Team (Chair) Science and Information Management Council Woodvale Research Centre Management Team (Member) *CALMScience* Editorial Board (Member) Library Coordinating Group (Coordinator) Feral Animals Control Committee (Member) Woodvale Joint Consultative Committee (Coordinator) WATSCU (Associate Member) Gilbert's Potoroo Interim Recovery Team	CRC Vertebrate Biocontrol Centre (Member Executive Committee) CRC Vertebrate Biocontrol Centre (Deputy Board Member) ANCA Feral Pests Program (CALM contract officer) Marandoo Environmental Management Committee (Member) Millstream Management Review Committee (Member) Woylie Recovery Team (Chair) Mulga Research Centre, Curtin University (Member)	

Internal	External representing CALM	External Non-Departmental
GEOFF STONEMAN		
Como Library Committee Forest Science Library Committee	Australian Forestry Council's Research Working Group 9 (Forest Hydrology) Bauxite Sub-committee of the Research Steering Committee	
MIKE STUKELY		
Glasshouse and Shadehouse Users Committee	Dieback Resistant Jarrah Group	
GRANT WARDELL-JOHNSON		
	Geocrinia Recovery Plan Research Working Group 10 Swan Avon ICMCG	Temperate Conference organising committee Australian bird and bat banding scheme (South-west representative)
STEPHEN van LEEUWEN		
Pilbara Fire Planning Team	CALM - HI SMU Liaison Committee (Committee member)	Nickol Naturalist Club Advisory Committee for Associate Diploma of Applied Science (Environmental Technology), Karratha College
JUDY WHEELER		
Herbarium Library Management Team Herbarium Curation Committee Herbarium Joint Consultative Committee Herbarium Centre Management *Nuytsia* Editorial Board SID Bio-resources Management Team		
RAY WILLS		
		Ecological Society of Australian (Bulletin Editor)
PAUL WILSON		
WACENSUS Standards Committee		

Internal	External representing CALM	External Non-Departmental

TECHNICAL STAFF

TONY ANNELS

Southern Forest Region Threatened Flora Recovery Team

ANDREW BROWN

Banksia cuneata Recovery Team

Central Forest Region Threatened Flora Recovery Team

Eucalyptus rhodantha Recovery Team

Endangered Flora Consultative Committee

Geraldton District Threatened Flora Recovery Team

Grevillea scapigera Recovery Team

Merredin District Threatened Flora Recovery Team

Pityrodia scabra Recovery Team

Southern Forest Region Threatened Flora Recovery Team

Stylidium coroniforme Recovery Team

Western Australian Native Orchid Study and Conservation Group Inc (Vice President)

TOM BURBIDGE

WA Insect Study Society (Inc)

COLIN CRANE

Plant and Isozyme Laboratories Users Committee

RAY CRANFIELD

Herbarium Curation Committee

Herbarium Management Team

Herbarium Joint Consultative Committee

Herbarium Safety Committee

Occupational Health and Safety Committee

SUZANNE CURRY

Herbarium Curation Committee

WACENSUS Standards Committee

WAHERB Standards Committee

Internal	External representing CALM	External Non-Departmental
CHANG SHA FANG		
Herbarium Management Team		
Herbarium Curation Committee		
WACENSUS Standards Committee		
WAHERB Standards Committee		
PHIL FULLER		
Western Swamp Tortoise Recovery Team		
Woodvale Safety Committee		
VICKI HAMLEY		
Herbarium Safety Committee		
KATHRYN LEE		
Computer Users Committee		
Como Library Committee		
MIKE LYONS		
Woodvale Joint Consultative Committee		
Woodvale Safety Committee		
BENG SIEW MAHON		
Herbarium Library Management Team		
GRANT PEARSON		
CALM Boat Management Committee		
Woodvale Library Committee		
Woodvale Management Team Committee		
Woodvale Safety Committee		
JIM ROLFE		
Lancelin Island Skink Recovery Team		
Woodvale Safety Committee		
PHIL SPENCER		
Herbarium Safety Committee		

Internal	External representing CALM	External Non-Departmental
FRANCIS TAY		
Como Joint Consultative Committee		
Glasshouse and Shadehouse Users Committee		
Plant and Isozyme Laboratories Users Committee		
ANDY WILLIAMS		
Woodvale Safety Committee		
ALAN WILLS		
Como Joint Consultative Committee		
Plant and Isozyme Laboratories Users Committee		
ADAM WINCZA		
Como Joint Consultative Committee		
Computer Users Committee		
LISA WRIGHT		
SID Libraries Management Team Committee	Government Librarians Network	Inmagic Users Group
	ABN Users Group	
Wildlife Science Library Management Team Committee		
Woodvale Management Team Committee		
Woodvale Joint Consultative Committee		

Seminars given in Western Australia

July 1992

G Friend and M Williams, 'Vertebrate life history parameters and fire: A conceptual framework for a predictive model'

R Moore, 'Pine timberbelts - integrating softwoods with farming'

G Stoneman, 'Factors affecting growth of Jarrah (*Eucalyptus marginata*) seedlings in the northern jarrah forest'

August 1992

N Lander, 'Exchanging taxonomic descriptive data'

G Wardell-Johnson, 'Implementing recovery plans: the case of two threatened frogs'

September 1992

S Halse, 'A preview of natural history studies at Lake Gregory'

J McGrath, 'Impact of site factors on productivity and drought susceptibility of *Pinus radiata* in the Blackwood Valley'

October 1992

G Friend and J Friend, 'Short-term impact of fire on a population of *Phascogale calura*'

N Marlow, 'The ecology of foxes in relation to biological control'

November 1992

R Harper, 'Development of a physical resource survey system for CALM's new plantations'

J Kinnear, 'Research Update on the Fox Problem' CALM, Narrogin

K Morris, 'The eradication of the introduced black rat *Rattus rattus* from Barrow and Middle Islands'

December 1992

G Keighery, 'Tuart forest: floristics, weeds and the future'

March 1993

D Coates, 'Isozyme electrophoresis' at the Conservation Genetics in Australia conference, Perth Zoo

May 1993

N Lander, T Macfarlane and A Chapman, 'Rare and endangered taxa descriptive database workshop pictures, descriptions and maps on counter'

L McCaw, presented talk on shrubland fire behaviour and response of shrublands to fuel modification treatment at the joint SID-Midwest Region Seminar, held in Geraldton

June 1993

J Kinnear 'Research Update on the Fox Problem' CALM Midwest Region, Geraldton

August 1993

AH Burbidge 'The Nullarbor Quail-thrush - indicator of range condition?'

P Pigott 'Management and distribution of Watsonia spp in WA - results from a questionnaire to land management authorities' at Watsonia Workshop

September 1993

N Burrows, 'A framework for assessing acute impacts of fire'

D Coates, 'Chromosome repatterning, population structure, genetic structure and speciation in SW Australian Trigger Plants' at Systematic Evolution and Conservation of WA Biota, University of WA

D Coates, 'Mating systems and variation in annual pollinated rare and endangered plant populations in WA' at Systematic Evolution and Conservation of WA Biota - University of WA

G Friend, 'Fire and Invertebrates - a review of research methodology and the predicability of post-fire response patterns' at Landscape Fires '93, Australian Bushfires Conference, Perth

G Friend, 'Impact of fire on fauna in remnant vegetation - research findings and their implications for management' at Remnant Vegetation Workshop, Dryandra

AM Gill, ND Burrows and R Bradstock, 'Fire modelling and fire weather in an Australian desert'. Landscape Fires '93. Australian Bushfires Conference, Perth

A Hopkins, 'Monitoring: Its role in living natural resources management'

L McCaw, 'Fire behaviour studies in Western Australian mallee-heath'

D Pearson, 'Fires, vegetation heterogeneity and small vertebrates in hummock grasslands, at Landscape Fires '93, Australian Bushfires Conference, Perth

D Pearson, Australian Rangeland Society Visions Workshop, Moondyne, WA

P Pigott, 'Fire, history mapping of remnant urban bushland near Perth, WA' at Landscape Fires '93, Australian Bushfires Conference, Perth

October 1993

NL McKenzie, 'Kimberley land snail biogeography: Implications for conservation'

D Pearson, 'Distribution, status and conservation of Pythons in Western Australia'

A Brown, 'Colour, scent, mimicry and outright deception'

November 1993

J Bathgate, 'Diplodina Canker of *Banksia coccinea*: Epidemiology of the disease and control options'

P de Tores, 'The release of rehabilitated orphaned and injured Western Ringtail Possums at Leschenault Peninsula conservation park'

M Williams, 'Stochastic models of the species-area relation'

December 1993

D Algar ' Research on control of feral cats'

M Yung, 'Time series analysis techniques: An introduction to its applications'

March 1994

J Kinnear, 'Impact Of Fox On Native Mammals', Rockingham Naturalist Club

April 1994

J Bathgate. and B Shearer '*Cryptodiaporthe* sp: a new canker pathogen *threatening Banksia coccinea*

S Bellgard and B Shearer 'Morphological variability exhibited by *Phytophthora megasperma* retrieved from diseased areas of Western Australian bushland'

F Bunny and B Shearer 'Distribution of *Phytophthora citricola* on soil surface and at depth in the northern jarrah forest'

DS Crombie 'Disease and forest production in WA'

E Davison 'Role of environment in dieback of jarrah. (Effects of waterlogging on jarrah, *P. cinnamomi* and infection of jarrah by *P. cinnamomi*) and Incipient rot and rot in regrowth karri'

G Friend 'Impact of plant disease on animal ecology'

G Keighery, N Gibson and D Coates 'Future ecosystems - ecological balance'

B Komorek and B Shearer 'Phosphonate offers a practical method for the control of *Phytophthora cinnamomi* in native plant communities'

B Shearer 'The major plant pathogens occurring in ecosystems of south-western Australia. Impact of *Phytophthora cinnamomi* infestation in Banksia woodlands on the Swan Coastal Plain south of Perth'; 'Impact of *Armillaria luteobubalina* infestation in coastal dune communities of south-western Australia'; 'Control options of plant pathogens in native plant communities in south-western Australia'

M Stukely 'Future ecosystems - use of genetic resistance'

R Wills and A Chapman 'Developing a GIS-based model to assist in the management and control of *Phytophthora cinnamomi*'

R Wills and G Keighery 'The ecological impact of plant disease on plant communities'

R Wills 'Fungi associated with cankers in Western Australian plant communities'; 'Cankers of native plant species from the south-west of Western Australia' and 'Threats of plant disease to the wildflower industry, tourism and beekeeping'.

June 1994

Sustainable Resources Group Technical Meeting:

T Butcher 'Globulus & pine breeding'

R Mazanec 'Globulus & native breeding'

L Barbour 'Propagation and nursery work'

R Harper 'Site selection'

J McGrath 'Tree nutrition'

S Crombie 'Water relations of pines'

P Christensen 'Indian sandalwood integrated with hardwood host'

R Moore 'Farm forestry and agroforestry'

I Abbott 'Globulus entomology'

J Bartle 'Vertebrate pests'

L McCaw 'Karri silviculture'

G Stoneman 'Jarrah silviculture'

G Siemon 'Wood utilizaton'

G Brennan/B Glossop 'Wood utilization'

G Friend 'Fauna, fire and logging'

K Morris 'Medium sized mammals and logging'

M Craig/G Wardell-Johnson 'Birds and logging'

K Whitford/G Stoneman 'Hollows and logging'

N Burrows 'Flora, fire and logging'

B McComb 'Predicting potential habitat'

J Armstrong 'Bioprospecting'

D Ward 'Boronia harvesting'

J Farr 'Wood borers'

I Abbott 'Jarrah leafminer'

E Davison '*Armillaria* and rots in karri'

S Crombie 'Jarrah growth on dieback sites, banksia removal'

B Shearer 'Phosphonate and jarrah growth, Pc site hazard rating'

M Stukely 'Pc resistant jarrah'

July 1994

A Hopkins 'Kwongan ecotones at Tutanning nature reserve'

D Coates 'Evolutionary patterns in *Stylidium* : implications for long term conservation strategies'

August 1994

G Friend 'Fire ecology of invertebrates: implications for nature conservation and fire management'

S Bellgard 'The control and management of Phytophthora megasperma in national parks'

S van Leeuwen 'Fire and its impact on the floristics of mulga woodlands in the Central Pilbara, WA'

September 1994

J Kinnear 'Impact Of Fox On Native Mammals' Ravensthorpe LCDC

B Komorek 'Phosphonate offers a practical method in the control of *Phytophthora cinnamomi* in native plant communities'

B Prince 'WA sea turtles'

October 1994

J Kinnear 'Rock wallaby research - 16 years on'

F Bunny 'Biology and ecology of *Phytophthora citricola* in native plant communities'

November 1994

G Wardell-Johnson 'Patterns of eucalypt distribution in the Darling botanical district, implications for conservation and sustainability'

December 1994

J Lane 'Black swan breeding in Busselton'

T Friend 'Conservation of the Quenda (*Isoodon obesulus fusciventer*)'

March 1995

J Kinnear 'Feral Predator Control Research in the FRNP', Friends of FRNP.

J Kinnear 'Impact Of Fox On Native Mammals', Ongerup LCDC

J Kinnear 'Impact of Fox on Native Mammals', Gnowangerup LCDC

D Coates 'Genetic conservation - its present and potential role in environmental management' Edith Cowan University

Presentations at scientific meetings outside of Western Australia

July 1992

T Friend, presentation of paper 'Red-tailed phascogale' at Australian Mammal Society, Melbourne.

D Coates, presentation of paper at symposium on ecological genetics, Genetics Society of Australia Annual Conference and Symposium on Ecological Genetics, Brisbane.

N Gibson, presentation of paper 'A comparison of the biogeographical patterns in south west Western Australia and Tasmania', Hobart.

G Friend, presentation of two papers at 1992 Annual General Meeting of the Australian Mammal Society on 'Impact of fire on the population dynamics, nest usage and movement patterns of the rare dasyurid *Phascogale calura*', Melbourne.

K Morris, presentation of paper 'Reintroduction of the Greater Stick-nest Rat to WA' at 1992 Annual General Meeting of the Australian Mammal Society, Melbourne.

November 1992

R Harper, presentation of poster paper at the First National Conference and Workshop on Sodic Soils, Adelaide.

December 1992

P Christensen, N Burrows, L McCaw, P Hewett and G Friend attended and made presentations at an Australian Forestry Council joint meeting of research working groups in Creswick, Victoria.

April 1993

T Friend, presentation of paper 'Reintroduction and the Numbat Recovery Program' at Conference on Reintroduction Biology of Australasian Fauna, Healesville, Victoria.

G Wardell-Johnson, presentation of paper 'To where do we reintroduce the frogs?' at Conference on Reintroduction Biology of Australasian Fauna, Healesville, Victoria.

P Christensen and N Burrows, presentation of paper 'Desert Dreaming' at Conference on Reintroduction Biology of Australasian Fauna, Healesville, Victoria.

S Halse, presentation of joint paper at Workshop on 'The Ecology and Management of Riparian Zones' at 32nd Conference of the Australian Society for Limnology, Maroochydore, Queensland.

K Morris, presentation of paper 'Reintroduction of the Chuditch to Julimar Conservation Park' at Conference on Reintroduction Biology of Australasian Fauna, Healesville, Victoria.

June 1993

J Kinnear, presentation of poster at International Symposium on Mammals, Sydney.

A A Burbidge, presented keynote address titled 'Practical methods for conserving biodiversity' at Biodiversity: Threats and Solutions Conference, Sydney.

July 1993

D Coates, presentation of paper 'Genetic systems and conservation strategies for endangered flora in Western Australia', at Conference on Conserving Biodiversity, Sydney and the Annual Meeting of the Genetics Society of Australia, Adelaide.

P de Tores, presented seminar on the release of the rehabilitated Western Ringtail Possum *(Pseudocheirus occidentalis)* at the 6th International Theological Congress, University of NSW, Sydney.

G Friend, presentation of paper 'Small mammal life history parameters and fire: a framework for a predictive model', at Sixth International Theological Congress, Sydney.

G Friend, presentation of paper 'Impact of fire on invertebrate communities in mallee heath shrublands in south-western Australia' at Invertebrate Conservation Conference, Brisbane.

D Pearson, presentation of poster 'The response of sympatric desert dasyurids to fire' at the 6th International Theological Congress, University of NSW, Sydney.

N McKenzie, presentation of poster-paper 'Structure of a palaeotropical bat fauna' to the 6th International Theological Congress, University of NSW, Sydney.

September 1993

P Pigott, presentation of paper 'Distribution of Bridal Creeper in WA' at the 10th Australian and 14th Asian Weeds Conference, Brisbane.

October 1993

R Wills, presentation of paper 'Plant disease and conservation priorities for plants in south-west Western Australia' at the Ecological Society of Australia Biennial Symposium, Canberra.

D Coates, presentation of paper 'Plant disease and conservation priorities for plants in south-west Western Australia' at the 1993 Symposia of the Ecological Society of Australia, Canberra.

S Patrick, presentation of poster 'Rare Flora Management Programs in the South West Botanical Province of Western Australia' at the Conserving Biodiversity Conference, Sydney.

November 1993

G Brennan, presentation of paper 'Equilibrium moisture contents of timbers commonly used in Western Australia' at the 24th Forest Products Research Conference, CSIRO Clayton, Victoria.

G Stoneman, presentation of papers 'Hydrological response to thinning a small jarrah (*Eucalyptus marginata*) forest catchment' and 'Water yield issues in the jarrah forest of south-western Australia' at the International Symposium on Forest Hydrology in Canberra.

December 1993

D Coates, chaired workshop on 'Species Reintroductions' in Cultivating conservation: integrated plant conservation in Australia Symposium, Hobart.

D Pearson, presentation of paper 'Fire-breeding dragons. Sympatric *Ctenophorus* and fire in the Great Victoria Desert" and presentation of poster 'Distribution, status and conservation of pythons in Western Australia', at the Second World Congress of Herpetology, Adelaide.

M Williams, presentation of papers 'Stochastic models of the species-area relation' and 'Use of principal component biplots to detect environmental impact' at International Conference on Statistics in Ecology and Environmental Monitoring, New Zealand.

May 1994

A H Burbidge, presentation of paper 'Western Australian mallee and Western Whipbirds' at Royal Australasian Ornithologists Union/South Australian Ornithological Association Scientific Day, Adelaide.

A Hopkins, presentation of paper 'Part 5, Options for long-term monitoring of arid and semi-arid terrestrial ecosystems in Australia' at CSIRO National Workshop, Canberra.

June 1994

I Abbott, presentation of paper by Jim Armstrong and Ian Abbott on 'Marketing the biota and landscapes of Western Australia's rangelands'. 8th Australian Rangeland Conference, Katherine, NT.

T Friend, presentation of paper `Red-tailed Phascogale, a Western Australian threatened marsupial' at Australian Mammal Society Conference, Hobart.

July 1994

S van Leeuwen, presentation of paper 'Impacts of fire and changes in fire regime on the biota of mulga communities within the Hamersley Range' at Ecological Research and Management of Mulgalands Conference in Gatton, Queensland.

S Halse, presentation of paper 'Salinity and aquatic invertebrates of Lake Gregory' at 6th International symposium on Saline Lakes in Beijing, China.

September 1994

D Coates, presentation of paper 'The conservation, management and Ex situ seed storage of threatened plants in Western Australia' at International Kew Chromosome Conference, England.

T Friend, presentation of paper 'Protecting Native Endangered Fauna from Predators' at the Nature Conservation Council of NSW.

T Friend, presentation of paper 'The Status of the Red-tailed Phascogale Phascogale calura' at the Ecological Society of Australia 1994 Open Forum and Symposium Conference, Alice Springs.

October 1994

G Friend, presentation of a paper 'Fire Ecology of Vertebrates and Invertebrates, Implications for Management and Future Research' at the Biodiversity and Fire - the Effects and Effectiveness of Management Conference, Melbourne.

T Friend, presentation of a seminar and workshop on 'Reintroduction of Mammals' at the Centre for Conservation Biology, University of Queensland.

November 1994

J Kinnear, co-presentation of paper 'The status of Rock Wallabies in WA' and 'A Case Study of Fox/Rock Wallaby Dynamics in the Wheatbelt' at the National Rock Wallaby Symposium , Adelaide.

D Pearson, co-presentation of paper 'The status of Rock Wallabies in WA', and `the role of Aboriginal people in rock wallaby survey and management' at the National Rock Wallaby Symposium, Adelaide.

D Pearson (on behalf of D Algar), presented paper 'The current state of knowledge on cat control' at the National Rock Wallaby Symposium, Adelaide.

December 1994

GJ Wardell-Johnson, presentation of paper 'Conserving biological diversity in temperate forest ecosystems - towards sustainable management' at the Biodiversity Conference, Canberra.

February 1995

T Butcher, co-presentation of paper 'The accelerated orchard system for *Eucalyptus globulus'* at CRC-IUFRO Conference, Hobart.

May 1995

G Keighery, presentation of 'Western Australian Overview' at Australasian Conference on Spartina control, Yarram, Victoria.

J McGrath, presentation of overview 'Western Australian experience' at Management of stand nutrition to increase the productivity of later aged softwood plantations: an Australian Perspective and future prospects workshop, Mt Gambier.

K Morris, presentation of 'The effect of fox control on native mammals in the jarrah forest, Western Australia' at 10th Australian Vertebrate Pest Control Conference, Hobart.

Publications and reports

ABBOTT, I

Abbott, I (1992). Biogeography of grasses (Poaceae) on islands of south-western Australia. *Australian Journal of Ecology* 17, 289-296.

Abbott, I (1992). Ecological implications of insect pests in jarrah and karri forests. *Department of Conservation and Land Management, Western Australia, Occasional Paper* 2/92, 77-98.

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Abbott, I (1993). Insect pest problems of eucalypt plantations in Australia. 6, Western Australia. *Australian Forestry* 56, 381-384.

Abbott, I (1993). Minimising insect pests in eucalypt plantations: a review in the context of the concepts of optimal area, polycultures and patchiness. *Australian Forestry* 56, 385-390.

Abbott, I (1994). Distribution of the native earthworm fauna of Australia : a continent-wide perspective. *Australian Journal of Soil Research* 32, 117-126.

Abbott, I (1994). Review of the ecology and control of the introduced bark beetle *Ips grandicollis* (Eichhoff) (Coleoptera: Scolytidae) in Western Australia 1952-1990. *CALMScience* 1(1), 35-46.

Abbott, I (1995). Prodromus of the occurrence and distribution of insect species in the forested part of south-west Western Australia. *CALMScience* 1(4), 365-464.

Abbott, I and Burbidge, A A (1995). The occurrence of mammal species on the islands of Australia: a summary of existing knowledge. *CALMScience* 1(3), 259-324.

Abbott, I and Christensen, P (1994). Application of ecological and evolutionary principles to forest management in Western Australia. *Australian Forestry* 57, 109-122.

Abbott, I and Christensen, P (1995). Looking beyond the obvious. *LANDSCOPE* 10(4), 22-27.

Abbott, I, Burbidge, T, Williams, M and Van Heurck, P (1992). Arthropod fauna of jarrah (*Eucalyptus marginata*) foliage in Mediterranean forest of Western Australia: Spatial and temporal variation in abundance, biomass, guild structure and species composition. *Australian Journal of Ecology* 17, 263-274.

Abbott, I, Van Heurck, P and Burbidge, T (1993). Ecology of the pest insect jarrah leafminer (Lepidoptera) in relation to fire and timber harvesting in jarrah forest in Western Australia. *Australian Forestry* 56, 264-275.

Abbott, I, Van Heurck, P and Burbidge, T (1993). Impact of frequency and intensity of defoliation on growth of jarrah (*Eucalyptus marginata*): an experimental study with saplings. *Forest Ecology and Management* 56, 175-183.

Abbott, I, Van Heurck, P, Burbidge, T, and Williams, M (1993). Damage caused by insects and fungi to eucalypt foliage: spatial and temporal patterns in Mediterranean forest of Western Australia. *Forest Ecology and Management* 5, 85-110.

Abbott, I, Van Heurck, P, Burbidge, T and Wills, A (1994). Factors influencing the performance of jarrah leafminer (Lepidoptera) within stands of jarrah forest in Western Australia. *Australian Forestry* 57, 165-170.

ALGAR, D

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ARMSTRONG, J

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BARTLE, J

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List of acronyms and abbreviations used

ABRS	Australian Biological Resources Study
AHC	Australian Heritage Commission
ANCA	Australian Nature Conservation Agency
APB	Agriculture Protection Board (WA)
CALM	Department of Conservation and Land Management (WA)
CSIRO	Commonwealth Scientific and Industrial Research Organization
DASET	Department of Arts, Science, Environment and Territories
DAWA	Department of Agriculture (WA)
DELTA	Descriptive Language for Taxonomy
DOPLA	Department of Productivity and Labour Relations
DRF	Declared Rare Flora
ERIN	Environmental Resources and Information Network
FIF(WA)	Forest Industries Federation of Western Australia
FRNP	Fitzgerald River National Park
GIS	Geographic Information System
HAPSO	Hedged Artificially Pollinated Seed Orchard
HERBIE	A computer software program enabling capture of plant specimen collection information
IMB	Information Management Branch
LAN	Local Area Network
OPSSO	Open-Pollinated Seedling Seed Orchard
NPNCA	National Parks and Nature Conservation Authority (WA)
Pc	*Phytophthora cinnamomi*
pc	Personal computer
PPC	CALM Plant Propagation Centre, West Manjimup
RIRDC	Rural Industries Research and Development Corporation
SID	Science and Information Division
SPP	Science Project Plan
STBA	Southern Tree Breeders' Association
VAX	Main computer (Proprietary) used in CALM
VCL	Vacant Crown Land
WACensus	Western Australian Census of Plants
WAN	Wide Area Network
WATSCU	Western Australian Threatened Species and Communities Unit
WMSO	West Manjimup Seed Orchard
WURC	Wood Utilization Research Centre