Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Science Division

Discovering the Nature of WA

OPERATIONS PLAN

January 2001 – June 2002

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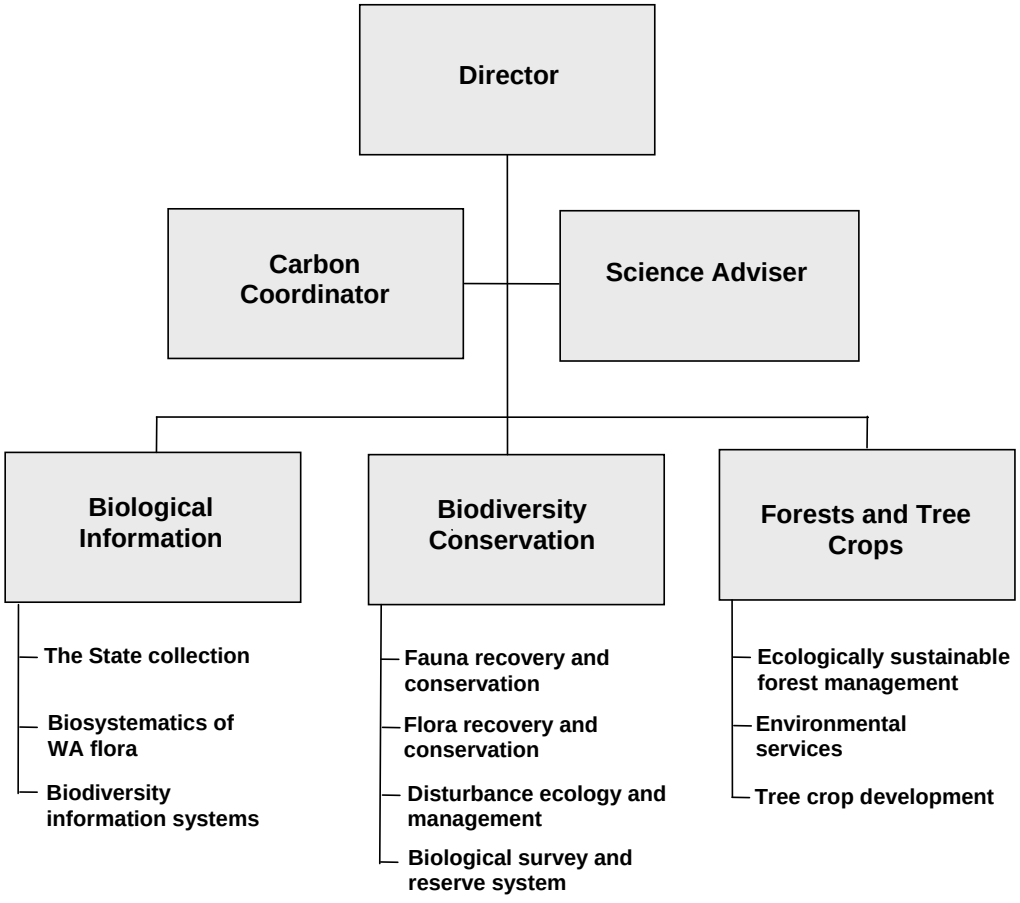
Science Division

The **Science** Division is one of seven Divisions in the Department of Conservation and Land Management and is one of four service provider Divisions. **Science Division** provides services to three Output Purchasers in CALM, the Nature Conservation Output, the Sustainable Forest management Output and the Parks and Visitor Services Output. The Executive Director may also purchase services from **Science** Division. The Division provides services to the Forest Products Commission and other external purchasers, including Alcoa of Australia, Biogene, community groups, Co-operative Research Centre for Greenhouse Accounting, Co-operative Research Centre for Tropical Savannas, Co-operative Research Centre for Pest Animal Control, Co-operative Research Centre for Marsupial Management, environmental consultants, Forest and Wood Products Research and Development Corporation, Natural Heritage Trust, privately operated sanctuaries, Rural Industries Research and Development Corporation, and Western Australian Police Service.

The **Science Division** is structured around three Key Science Themes, or Groups:

SERVICE DELIVERY STRUCTURE



The Director, the three Group Managers and the Science Adviser comprise the Science Management Council (SMC), which develops strategic plans, business plans and service provider agreements, and determines policy and resource allocation within the Division. Group Managers are responsible for ensuring that science services provided by the Group are delivered effectively, efficiently and at a high standard to end users, and for ensuring that relevant scientific expertise in the Group is integrated and coordinated within the Group and throughout the Division. Outcome-based, multi-disciplinary teams (Programs) that align with the Division's Key Result Areas support each Group. Each is administered by a Program Team Leader who is responsible for the integration of priorities within a program, the effectiveness and quality of the research, and fostering interaction within the program and with other relevant staff. The Carbon Coordinator is responsible for the development and implementation of policy relating to carbon sequestration and this service is purchased directly by the Executive Director.

The Division's activities are spread throughout Western Australia with major research centres, providing laboratory and other support facilities, located at Woodvale, Kensington and Manjimup. Other Divisional staff are located at CALM Regional and District offices at Dwellingup, Busselton, Albany, Karratha and Kununurra. Co-located at the Research Centre at Kensington is the CALM WA Herbarium, the principal State botanical collection. Regional herbaria are located at Karratha, Manjimup, and Albany; and library and information services are located at Kensington and Woodvale.

PURPOSE OF THIS PLAN

The **Science** Division Business Plan sets out the role of the Division as a service provider to purchasers within the Department of Conservation and Land Management (CALM) and the Forest Products Commission (FPC). This Operations Plan supports the Business plan by providing details of the specific programs and projects of the Division. It describes the objectives, significance and benefits, expected results, outcomes and adoption strategies of the Division's Key Result Areas (Programs) and the key activities, milestones and outputs of each science project. Further detail about individual science projects is also available in the WA Science Project Plans (WASPP) database on the Science Division website.

Science Division will deliver services to the CALM Nature Conservation, Sustainable Forest Management, and Parks and Visitor Services Divisions, and the Forest Products Commission through the mechanism of Service Provider Agreements and the implementation of this Operations Plan. The milestones identified for each science project will be the means by which the Division reports against the service delivery identified in the Service Provider Agreements.

Science Division SERVICE DELIVERY PLAN

During the period January 2001 – June 2002 the **Science Division** will implement the following plan to provide agreed services to underpin conservation and land management in an efficient and effective manner. This plan will be used to track the delivery of services and to serve as a mechanism for reporting performance.

BIOLOGICAL INFORMATION GROUP: THE HERBARIUM

KEY SCIENCE THEME: *Description and documentation of Western Australia's biological diversity (Biological Information Group).*
Western Australia has a very rich flora and fauna with a diverse array of ecosystems and habitats. **Science** Division will continue with the inventory of systematic, biological and ecological information on the native and alien biota.

KEY RESULT AREAS:
- Program 1 The State Collection
- Program 2 Biosystematics of WA flora
- Program 3 Biodiversity Information Systems

AIM: *To maintain and extend the State resource centre for taxonomic, conservation and economic information on the flora and, in collaboration with other institutes, other biota of the State*

RELEVANT CORPORATE OBJECTIVES:

A. To protect, conserve and, where possible restore, Western Australia's natural biodiversity.

B. To generate social, cultural and economic benefits through the provision of a range of services that are valued by the community and are consistent with the principles of ecological sustainability.

C. To develop community awareness and appreciation of the biological and physical diversity natural to Western Australia and promote community involvement in and support for its protection, conservation and restoration.

PURCHASERS:
- Nature Conservation
- Parks and Visitor Services
- Executive Director

Program 1: The State Collection

Program Leader: Mr Chang Sha Fang

Output Purchasers: Nature Conservation, Parks & Visitor Services

Key Result Area
The State Collection serves the Departmental functions as specified in the Conservation and Land Management Act 1984, Section 33 (1) (db), '*To be responsible for the permanent preservation of the plant collections of the Western Australian Herbarium and to care for and extend those collections*'.

The Bioprospecting core function serves Section 33 (1) (ca*)* of the CALM Act: '*To promote and encourage the use of flora for therapeutic, scientific or horticultural purposes for the good of people in this State or elsewhere, and to undertake any project or operation relating to the use of flora for such a purpose*'.

This program contributes to the Nature Conservation Output Strategic Plan objectives of '*An understanding of our State's natural biodiversity and biodiversity conservation needs',* and '*A Department that works effectively with the wider community to achieve biodiversity conservation and a community that is knowledgeable about, interested in, supportive of, and involved in, biodiversity conservation*'.

Description
As a permanent, fully databased repository of plant specimens and information about them, the WA Herbarium collections underpin much of the scientific research and many of the environmental management activities of the Department and those of external organisations. The latter include the Forest Products Commission, Environmental Protection Authority, Agriculture WA, Department of Land Administration, other government agencies, universities, regional herbaria, and community interest groups concerned with land management.

In particular, this Program curates the collection by transferring biosystematic outputs produced by biosystematic projects (Program 2), and provides the baseline data for electronic capture and dissemination by biodiversity information systems (Program 3).

Objectives
The program seeks to: -

- Increase specimen based knowledge of the native and alien WA flora.
- Maintain and extend the State's scientific collection of specimens at the Western Australian Herbarium (PERTH) to adequately represent species distribution and variation
- Secure the State Collection from fire, insect attack and unauthorised access.
- Provide adequate and safe storage for the State Collection
- Provide a sound basis for a comprehensive plant information system in conjunction with the other Herbarium programs
- Maintain currency of names in the corporate species names database (WACENSUS), the State Collection and the specimen database (WAHERB)
- Operate a Regional Information Network of trained regional "para-taxonomists" whose activities are focused on local herbaria in collaboration with Landcare and kindred Groups.
- Train Network Groups to collect well-documented voucher specimens and thus make substantial contributions to CALM corporate knowledge of native flora and weed species of the State.
- Empower local groups of para-taxonomists to be custodians of knowledge of their own regional plants through skills training and education.
- Provide services to the Executive Director, CALM, and BioProspecting Ltd. Bioprospecting agreement
- Manage and extend the plant extracts library and curate related voucher specimens incorporated in the State Collection.
- Collect and process bioprospecting samples of WA vascular flora.
- Ensure appropriate financial returns to CALM.
- Ensure that collection of material does not compromise conservation values of habitats or taxa.

Significance and Benefits:
The acquisition and databasing of annotated, accurately identified and well-curated specimens by the State Collection underpin all efforts to conserve Western Australia's unique and diverse flora. Authoritative, vouchered base-line scientific data concerning the flora and ecosystems of the State are provided by the collection and its attendant electronic information systems.

The Visitor Centre at the WA Herbarium and its on-line information systems promote greater awareness and appreciation of the WA flora by the community, provide an essential service to CALM staff and external consultants working in the area of conservation and land management, and increase the availability of tourism information to local bodies. These benefits are extended by the Regional Herbarium Network, thus fostering and further developing local knowledge of the State's flora and of conservation issues amongst a wide range of community-based organizations, including salinity action, Landcare Groups and other conservation programs. Similarly, the documentation of the distribution and biology of weeds, and coordination of the Weeds Information Network. State Collection underpins both government and community initiatives in dealing with a major conservation and agricultural problem. By these means, CALM and the community have access to a pool of enthusiastic and trained regional "para-taxonomists".

Bioprospecting with industry partners enables the development and implementation of appropriate collecting methodologies for the sustainable utilisation of WA biota. Furthermore, it provides for the funding of conservation work from income derived from this activity.

Targets/Results Expected

- Attain a total holding of 505,000 vascular plant specimens (approximately 40 specimens per taxon).
- Achieve repatriation of historical (type) collections of species of 5 WA genera held in other herbaria.
- Redress current threats to the State Collection from fire, insect attack and unauthorised access.
- Provide adequate and safe storage where shelving holds no more than 750 grams of specimen and paper material per linear metre.
- Obtain funding to process appropriate specimens from the current backlog of 90 000 specimens.
- Add 100 specimens to the Reference Herbarium Collection to reflect variation of species.
- Add 5000 named and well-annotated specimens to the collection.
- Secure representative collection of voucher specimens from CALM plant-based projects where these add to knowledge.
- Expand the Reference Herbarium Collection to represent 90% of the currently accepted WA species.
- Develop and implement a program to monitor and voucher an adequate representation of specimens from flora licences issued.
- Actively forge further links with salinity, Landcare, weed study and info-tourism groups in WA regions.
- Recruit and train three new "para-taxonomists" to staff the volunteer identification unit at the WA Herbarium

Tasks / Activities – Relevant Science Project Plans

Program 2 tasks are listed below. Most tasks/Activities relate to Core Functions that are the key activities of all three Programs in the Group.

Core Function / SPP	**Project Title**	**Key Activities**	**Milestones** ***Quarterly***	**Outputs** *Dec. 200 – June 2002*
1.1	**Curation of State Collection**	• Provide safe storage for the collection • Maintain and extend the general vascular and other plant collections • Maintain currency of names • Database incoming specimens • Provide efficient identification facilities for CALM staff and other clients • Voucher all alien flora taxa • Voucher all conservation taxa • Maintain the Library holdings of relevant taxonomic literature • Facilitate access to and the loan of specimens for taxonomic study	03/01 • Database & incorpor. 850 new specimens • Add 18 specimens to Reference herbarium to reflect morphological variation • Validate label data & geocodes on 170 specimens • Add 75 new insertions and 40 edits to nomenclatural database 06/01 • Database and incorporate 850 new specimens • Add 18 specimens to Reference herbarium to reflect morphological variation • Validate label data and geocodes on 170 specimens • Add 75 new insertions and 40 edits to nomenclatural database • Secure the State collection from fire, insect attack and unauthorised access • Obtain funding & furnish "ballroom"	• 5 000 new specimens databased in WAHerb (specimen database) and incorporated in Collection • Repatriation of historic type specimens from 5 genera. • 100 specimens added to Reference Collection • 1 000 specimens validated • 450 insertions and 240 edits made to WACensus (nomenclatural database) • Improved adequacy and representativeness of the State Collection • Accessible flora information to support conservation research and management • Support system of well-trained, enthusiastic CALM volunteers

			(portable unit) as 3 offices & furnish offices currently under main roof as specimen storage areas • Obtain funding for current specimen backlog of 90 000 specimens & implement 09/01 • Database and incorporate 850 new specimens • Add 18 specimens to Reference herbarium to reflect morphological variation • Validate label data and geocodes on 170 specimens • Add 75 new insertions & 40 edits to nomenclatural database 12/01 • Database and incorporate 850 new specimens • Add 18 specimens to Reference herbarium to reflect morphological variation • Validate label data and geocodes on 170 specimens • Add 75 new insertions and 40 edits to nomenclatural database • Attain adequate storage space on each shelf with less than 750 gm specimen weight 03/02 Database & incorporate 850 new specimens • Add 18 specimens to Reference herbarium to reflect morphological variation • Validate label data and geocodes on 170 specimens • Add 75 new insertions and 40 edits to nomenclatural database 06/02 • Database and incorporate 850 new specimens • Database and incorporate backlog specimens (contingent on funding) • Add 18 specimens to Reference Herbarium to reflect morphological variation • Add 75 new insertions & 40 edits to	

			nomenclatural database • Achieve repatriation of 5 WA genera held in overseas herbaria • Validate label data and geocodes on 170 specimens	
1.2	Regional Herbaria Network	• Maintain community involvement and support • Support a network of trained "parataxonomists" • Acquire well-documented collections to fill State Collection knowledge gaps • Communicate effectively with Regional Herbaria and key stakeholder groups • Provide an efficient identification service for collaborating groups	03/01 • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 1 training workshop held • Ongoing ('bridging') funding obtained for Regional Herbaria Network Project • NHT grant applied for 06/01 • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 2 training workshops held 09/01 • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 2 training workshops held 12/01 • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 1 training workshops held • NHT Grant awarded 03/02 (subject to NHT funding) • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 2 training workshops held 06/02 (subject to NHT funding) • 166 specimens added to collection • 3 conservation taxon populations located and vouchered • 2 training workshops held	• 1000 specimens added to the Collections • 80 active regional herbaria supported • 10 training sessions held • 18 conservation taxon populations located and vouchered
1.3	Weed Information Network (WIN)	• Initiation of network parallel with Regional Herbarium Project • Determination of an	03/01 • Equipment & other necessary infrastructure assembled	• Weed Information network established with key stakeholders • 10 Workshops held

	Administration and curatorial components are dealt with under Program 1; the taxonomy is presented under program 2, Project 3	official list of WA alien plant invaders • Acquisition of well-documented voucher weed specimens • Training programs for weed surveillance • Establishment of an online information system for alien species • Alien species identification validated	• Protocols for specimen handling and information management established • 1 training workshop held 06/01 • 2 training workshops held 09/01 • 2 training workshops held 12/01 • 2 training workshops held • Launch of online information system for alien species • Publication of a comprehensive voucher-based checklist list of WA alien taxa • List of weed species for each shire communicated to appropriate office and AGWest staff **Further progress subject to NHT funding** 03/02 (subject to NHT funding) • 2 training workshops held 06/02 (subject to NHT funding) • 2 training workshops held	• 100 weed descriptions completed • Authoritative list of weeds for each shire communicated to appropriate officer and AGwest staff • Online information retrieval and weed identification system available (via FloraBase)
1.4	Services to the CALM-BioProspecting Ltd. Bioprospecting agreement	• Provide services to the CALM BioProspect Ltd agreement • Manage the Extract Library • Collect material to service the Agreement	03/01 • Establish meeting timetable • Supply of 1166 extracts • New collections made and processed (as required) 06/01 • Supply of 1166 extracts • New collections made and process (as required) 09/01 • Supply of 1166 extracts • New collections made and processed (as required) 12/01 • Supply of 1166 extracts • New collections made and processed (as required) 03/02 Supply of 1166 extracts • New collections made and processed • (as required) 06/02 Supply of 1166	• Quarterly meetings with BioProspect Ltd • 7,000 extracts supplied

			extracts • New collections made and processed (as required)	

Performance Indicators

- The number of specimens databased and incorporated into the State Collection
- The number of specimens incorporated that satisfy taxonomic, geographic and collecting period lacunae
- The number of threatened flora locations documented
- The number of specimens received from regional herbaria according to protocols established for the Regional Herbarium Project
- The number of regional based volunteer collectors
- The number of wed species correctly named
- The number of new weed populations located and documented
- The number of local government areas for which known weed populations are listed and located
- Departmental income derived from bioprospecting

Anticipated Outcomes

- Provision to land and conservation managers and others of accurate and up-to-date baseline data concerning the identification and distribution of WA flora (including fungi) and alien plants.
- Improvement in public knowledge and appreciation of the State's flora.
- Availability of a pool of well-trained and enthusiastic CALM volunteers at the WA Herbarium
- Provision of a vehicle to enable CALM staff to join with informed and trained members of the community (Regional Herbarium Network "parataxonomists") towards common conservation goals
- Meeting of obligations under the CALM-BioProspecting Ltd. Bioprospecting agreement
- Creation of an internationally recognised model demonstrating how herbaria and plant taxonomy can be made directly relevant to conservation, to industry partners, and to the community

Adoption/Uptake Strategy

- Disseminate data concerning the identification and distribution of WA flora and alien plants via the WA Herbarium's electronic information system FloraBase. Prepare and disseminated customised sub-sets of this data as required.
- Effect the necessary technology transfer concerning the use of data uptake tools, online information retrieval tools, specimen collection, preparation and documentation procedures by means of raining workshops, seminars, meetings, etc.
- Promote the importance and usefulness of the WA Herbarium collections and information systems by means of publications, seminars, meetings, committee membership, advice to the Nature Conservation Division etc.
- Make available the Reference Herbarium and, where necessary, the State Collection itself and its Library to CALM staff, bona fide researchers and external clients (the latter on a cost-recovery basis).
- Supply bioprospecting extracts to contracted industry partners on a commercial basis, with supporting data adequately safeguarded.

Partnerships/Collaborators

In pursuit of its objectives this program will enter into collaborative arrangements with the following organisations:

- Australian Herbaria
- Overseas Herbaria particularly in UK and France
- Government agencies dealing with land management issues
- Botanic Gardens Authority
- Western Australian Museum
- WA Tertiary institutions
- Approved industry partners

Program 1: Staff

CC 556 WA Herbarium
PROGRAM 1 The State Collection

Name	Position	Level		FTE	**1.1 Curation**	**1.2 Regional Herbarium**	**1.3 (WIN) Weed Info Network**	**1.4 Bioprospecting**
N Marchant*	Group Manager	8	3	1	0	0	0	0.1
J Wheeler*	Sr Research Sc	6	4	1	0.1			
C S Fang	Collections Mgr	5	4	1	0.8			
R Cranfield	Sr Technical Off	4	3	1	0.1			
K Knight	Technical Off	3	4	0.7	0.7			
C Parker	Technical Off	3	4	0.5	0.5			
P Spencer	Technical Off	3	4	1	0.5			
J Eygenraam	Clerical Officer	1	14	0.5	0.5			
S Carroll	Database Mgr	3	4	0.5	0.2	0.3		
K Veryard	Clerical Officer	1	14	0.5	0.3		0.2	
Sub Total: CRF				18.0	3.7	0.3	0.2	0.1
	Program Total Staff							**3.8**

Program 1: Budget

CRF (sal +overheads$215 599 ops costs $161 000)	**Total CRF**	**$376 599**
Ext/recoup funds (4.5 FTE sal + overheads $196 819 ops costs $4000	Total Ext	$200 819

Impact from other CALM botanists (curation, Nuytsia, FloraBase) est at $72 000

Program 2: BioSystematics of the WA Flora

Program Leader: Dr Terry Macfarlane

Output Purchasers: Nature Conservation, Parks & Visitor Services

Key Result Area
Taxonomy, which is a component of biosystematics, is a Departmental function cited in the Conservation and Land Management Act 1984, Section 33 (e), *'to carry out or cause to be carried out such study or research of or into - (iii) the taxonomy of flora and introduced plants.*

Biosystematics contributes to the Nature Conservation Output Strategic plan objectives of *'An understanding of our State's natural diversity and biodiversity conservation needs.' Biosystematics* and '*A Department that works effectively with the wider community to achieve biodiversity conservation and a community that is knowledgeable about, interested in, supportive of, and involved in, biodiversity conservation*'

Description
The Program produces and synthesises biosystematic information that is transferred to the herbarium

specimens by curation of the specimen collection (Program 1). It also provides the taxonomic basis for biodiversity information systems (Program 3).

Western Australia's terrestrial flowering plant flora is one of the most diverse in the world, yet many of the species are threatened. Knowledge of the flora is hampered by inadequately defined species, and poorly surveyed species. There is high public interest in the identification of vascular flora. Increasing attention is being paid to fungi, marine and other non-flowering plants.

Census
The Vascular Plant Census is kept up to date and that entries are verifiable through specimens or published articles, and changes are only made after critical assessment, which requires a good knowledge of the International Code of Botanical Nomenclature. Significant staff resource is allocated to the scientific filtering of additions and amendments. Some of the information derives from taxonomic research conducted within this Program. Censuses are central to other species information databases.

The computer system development and maintenance aspects are a function of the Biological information Systems Program. Data entry is a function of The State Collection Program.

Systems of classification
The grouping of species into genera, families and higher groups is important information that expresses properties of the organisms and helps people to understand how species relate to one another. The classifications are not static because new information or interpretations continually accumulate, through research within the Program and externally.

Internationally acceptable scientific nomenclature
The Herbarium adheres to the internationally accepted standard method of naming organisms, to ensure that our work meets the standards of the world scientific community. It links to the defining of species, through the objective method of associating names with Type specimens.

Well-defined species
Original taxonomic research is carried out to define individual species. This is necessitated by perceived problems with some species (as to whether one or more species occur in a particular circumstance, and where each lives, and how they may be recognised). Outcomes include combining so-called species into fewer real species, and the recognition of previously unknown or undescribed species. Substantial resources are put into the defining of species of conservation interest (threatened or endangered) so that the resource for conserving, and legal protection is given to species whose definition is founded on science.

Adequate descriptions and images
Descriptions provide the definitions of species (and other groupings such as genera), and are the source of information used to provide keys and other identification tools, and they also provide information about organisms for publications and reports. Descriptions are prepared for scientific articles, Floras and field guides, reports, and also for databases and computer network information systems.

Database systems
Databases provide ways of storing and maintaining descriptive information in an organised electronic form. This new methodology provides improved efficiency and effectiveness. Various kinds of output, both electronic and hard copy, and permits entirely new ways that people can access and use taxonomic information. Databases and their outputs are equivalent to traditional hard copy publication.

Collections
The scientific collections of specimens are augmented by this Program through the improvements in identifications of existing specimens via the process of taxonomic research (e.g. the defining of species), and also through the naming of new collections made in the course of field investigations. WA is still relatively poorly collected, so new collections made under the direction of the Program improve the physical basis on which our knowledge of the biota is based. The Program is closely integrated with the State Collection Program, which has the responsibility for curation and maintenance of the collections.

Objectives
The program seeks to use the best possible practices to: -

- Provide a picture of biodiversity in WA by means of reliable censuses of organism groups and a system of classification reflecting the relationships of organisms.
- Define species and provide an authoritative scientific nomenclature for them.

- Develop and make available descriptive and image information and means of identifying organisms.
- Augment scientific collections of organisms and relevant database systems.

Significance and Benefits

- The Program conducts research on selected taxa to resolve taxonomic problems. Taxonomic studies of species on the Declared Rare and Priority Flora List are the highest priority for study. Soundly based delimitation of species, their clear circumscription, and adequate means to identify them reliably are necessary scientific and legal preludes to their protection and management.
- The Program will provide the scientific input to biodiversity inventory for WA, which provides the essential basic information on which species conservation and ecosystem management are based.
- As it is based on the major physical collections of WA organisms and associated library, databases and staff expertise and research, the Program provides a uniquely verifiable, authoritative and maintained resource. This enables conservation scientists and managers to communicate effectively and unambiguously about plants. And it is vital to enable the interpretation of data gathered over past years where classifications and the names of species have inevitably changed.

Targets / Results Expected

- Provide a name for every conservation taxon, either an informal "phrase name" or a formal name comprising valid genus and epithet, immediately after recognition as a distinct entity
- Add new State records and new taxon names to WACensus as soon as they are formally published
- Elucidate taxonomic problems in conservation taxa as far as classical methods allow
- Develop collaborations with other Institutes and laboratories to utilise DNA and other technologies
- Publish results of taxonomic studies in scientific journals and in the descriptive component of FloraBase

Tasks / Activities – Relevant Science Project Plans

Program 2 tasks are listed below. Most tasks/Activities relate to Core Functions that are the key activities of all three Programs in the Group.

Core Function SPP	Project Title	Key Activities	Milestones *Quarterly*	Output *Dec 2000-June 2002*
2.1	Biosystematics of DRF and priority taxa	• Provision of formal or informal name for each conservation taxa • Identification and resolution of taxonomic problems • Collaborative studies with specialist botanists initiated (where necessary) • Maintenance of DRF information on FloraBase • Provision of assistance and advice (as required) to ensure integrity of taxonomic and nomenclatural data in WACensus	03/01 • 8 taxonomic problems resolved 06/01 • 8 taxonomic problems resolved 09/01 • 8 taxonomic problems resolved 12/01 • 8 taxonomic problems resolved • Declared Rare and Priority Flora List updated 03/02 • 8 taxonomic problems resolved 06/02 • 8 taxonomic problems resolved	• 48 taxonomic problems reported on • Declared rare and Priority Flora list finalised annually and sent to Minister
SPP 93/0011	Taxonomic studies of species on the Declared Rare and Priority Flora List.	• Taxonomic research on poorly known Western Australian plants, particularly those of conservation priority	03/01 • Corrections to the *Petrophile* paper (in press). 06/01 • First update to Ken Atkins on taxa with conservation status. 09/01 • Preparation of a	• 2 papers published • Priority Flora List kept updated by addition of new taxa and alterations to the existing entries

			publication on Tiliaceae to include illustrations from an unpublished report. 12/01 • Second update to Ken Atkins 03/02 • Preparation of updated key to *Pityrodia* species. 06/02 • Third update to Ken Atkins.	
SPP 95/0008	Taxonomy of new, rare and priority plant species of the southern forests.	• Revisionary studies of critical species groups in *Tetratheca, Gastrolobium, Hydatella, Platytheca, Amphibromus & Patersonia* • Porting of DELTA data sets to FloraBase	03/01 • Paper determining the status of *Tetratheca elliptica* and describing a new species finished. 06/01 • Paper describing a new species of *Gastrolobium* finished 09/01 • Paper sorting out Southern Forests *Hydatella* finished. 12/01 • Paper describing variation in *Platytheca* finished. 03/02 • Paper establishing identity of southern *Amphibromus* finished. 06/02 • Paper on status of *Patersonia xanthina* finished.	• 6 papers published describing new species or sorting out confused taxonomy completed, along with associated information submitted to FloraBase.
2.2	Biosystematics and conservation status of native taxa			
SPP 93/0006	Taxonomic studies in the Asteraceae.	• Revisionary studies of *Olearia* • Systematic studies of tribe Astereae • Porting of DELTA data sets to FloraBase	03/01 • Complete conversion of current descriptive database to DELTA Editor Format 06/01 • Conversion of *Olearia* specimen and nomenclatural data to suitable database system (? Brahms) • Complete paper *on Olearia axillaris* group in WA 09/01 • Check and remedy DELTA coded Astereaceae genera of WA data set • Complete paper describing 3 new species of WA *Olearia* 12/01 • Complete paper describing new WA	• Publication of 6 papers describing ca 20 new species of Astereaceae. • Complete WAGenera DELTA data set for Asteraceae genera

			genus, *Pilbara* 03/02 • Complete paper on *Erodiophyllum* 06/02 • Complete paper describing 6 new species of *Olearia* • WA *Olearia, Erodiophyllum, & Pilbara* data ported to FloraBase	
SPP 93/0008	Taxonomy and inventory of WA flora: legumes, grasses and lilies.	• Revisionary studies of critical groups of *Amphipogon*, Stipeae, *Haemodorum, Urodon, Neurachne & Austrodanthonia* • Porting of DELTA data sets to FloraBase	03/01 • Treatment of *Amphipogon* for Flora of Australia completed. 06/01 • Treatment of Stipeae for Flora of Australia completed. • Paper on some new species of *Haemodorum* finished 09/01 • *Stipeae, Amphipogon* DELTA data sets placed appropriately in FloraBase with interactive key 12/01 • Revision of *Urodon* completed. 03/02 • Paper on a new species of *Neurachne* finished. 06/02 Paper on a new species of *Austrodanthonia* finished	• 6 publications completed, and additional electronic information submitted to FloraBase.
SPP (new)	Taxonomic studies in *Hibbertia*	• Taxonomic studies on the genus *Hibbertia* • Publication of results • Notification of conservation issues • Update of specimen holdings and FloraBase entries	3/01 • Completion of paper on *Hibbertia glomerosa* and its allies 06/01 • Completion of paper on the taxonomic clarification of *Hibbertia glomerata* • Completion of paper on the taxonomic clarification of a subgroup of *Hibbertia* and the publication of two new species from the south coast 09/01 • Publication of a paper with Helmut Toelken dealing with the nomenclature of *Hibbertia enervia* 12/01 • Completion of paper on the taxonomic clarification and new taxa in the *Hibbertia depressa* group • Completion of a	• 6 papers sorting out the taxonomy of particular plant groups completed, conservation records concerning them updated, and identification system for *Hibbertia* made available • All *Hibbertia* descriptive data published in FloraBase

			paper on the taxonomic clarification and new taxa in the *Hibbertia eatoniae* group 3/02 • Preparation of descriptions of new taxa in *Hibbertia* 6/02 • Completion of a paper on miscellaneous new *Hibbertia* species • Preparation of draft key to the WA species of the genus *Hibbertia* • WA *Hibbertia* descriptive data incorporated into FloraBase	
SPP (new)	Taxonomy and conservation status of *Agonis.*	•	• Taxonomic revision of Agonis and its segregate genera	• Publication of 3 papers on *Agonis* and its allies in WA • Update of specimen holdings and FloraBase entries
SPP (new)	Systematics and conservation status of the Epacridaceae	• Revisionary studies of the genus *Leucopogon* • Systematic studies of tribe Styphelieae • Floristic studies in the family Epacridaceae	03/01 • Current descriptive data for *Leucopogon* converted to DELTA Editor format • Paper describing the new WA species *Monotoca aristata* submitted 06/01 • Report on epacrid conservation taxa and their current status submitted • DELTA dataset integrated with WA Herbarium core characters • Development of an online specimen and nomenclatural database system for • Epacridaceae species commenced • Two seminars given on the taxonomic status of Epacridaceae and its largest • genus *Leucopogon* 09/01 • Online specimen and nomenclatural database system loaded with nomenclatural • information for Epacridaceae and type information for *Leucopogon* • Application for ABRS funding for Epacridaceae for the Flora of Australia • Submitted	• Publication of 2 papers describing new species of Epacridaceae • Publication of a report into conservation status of Epacridaceae species • Epacrid database online and maintained with national collaboration • Western Australian *Leucopogon* DELTA data set published in FloraBase

			12/01 • Online specimen and nomenclatural database system updated with *Leucopogon* • descriptions • Epacridaceae web interface demonstrated to national collaborators 03/02 • Specialist curation of WA Herbarium specimens of *Leucopogon* complete • Type material of WA *Leucopogon* species examined and annotated 06/02 • Paper describing new species of *Leucopogon* submitted • WA *Leucopogon* descriptive data incorporated into FloraBase	
SPP (new)	Taxonomy and conservation status of *Baeckea* Group.	• Revisionary studies of *Baeckea s. lat.* and related genera (including *Thryptomene*) of the Myrtaceae • Update of the lists of taxa in these genera with conservation priority	03/01 • Type material requested from BM, MEL 06/01 • Descriptions of members of *Thryptomene* sect. *Astraea* completed 09/01 • Paper describing the new genus *Enekbatus* submitted 12/01 • Investigation of the generic limits of *Thryptomene* and its allies 03/02 • Paper on *Thryptomene* sect. *Astraea* submitted 06/02 • Description of species currently included in the smaller sections of *Thryptomene* prepared	• Submission of two papers on the Myrtaceae, one describing a new genus of 6 species and the other a section with over 20 species
2.3	Weed taxonomy, biosecurity assessment, incursion monitoring: (Specimen curation and public interface component is dealt with under Program 1, project 3; databasing systems are the developed by Program 3)	• Correct names applied to weeds of State significance • Development of an electronic flora of alien invasive species • Databasing of biological information (biosecurity assessment)	03/01 • Overseas network established to source biological and habitat information • Descriptive character set established • Electronic flora team of staff and volunteers trained to gather descriptive data • 15 weed descriptions coded 06/01 • 17 weed descriptions coded 09/01 • 17 weed descriptions	• 100 comprehensive species descriptions available in FloraBase • Authoritative list of weed taxa published and available electronically

			coded 12/01 • 17 weed descriptions coded • Names of all weed collections confirmed **Further progress subject to NHT funding** 03/02 • 17 weed descriptions coded 06/02 • 17 weed descriptions coded	

Performance Indicators

- Number of new species described and number of species redefined
- Number of genera, species and infraspecific taxa provided with comprehensive descriptions enabling identification
- Number of taxon descriptions added to FloraBase
- Number of herbarium specimens annotated

Outcomes

- Authenticated list of Declared Rare and Priority Flora List taxa, updated annually
- A reliable source of specialist advice and collaboration with WATSCU and other relevant CALM staff concerned with the taxonomy of conservation taxa
- A sound scientific basis for Biodiversity Inventory, critical to many aspects of CALM's research and management work.
- Enhanced knowledge and appreciation of the identity, occurrence and properties of native plants amongst CALM staff, external clients and the general community. This function is proving important in educating people in the Wheatbelt about the ground layer of herbaceous plants as components of remnant vegetation, and in distinguishing between weedy and native grasses. Use of grasses in restoration, particularly of saline areas, is an important new direction largely due to access to Herbarium taxonomic expertise.

Adoption / Uptake Strategy

- Taxonomic work is primarily published as research papers in the CALM journal Nuytsia, and so is accessible to staff with a technical interest and background until incorporated into the information system FloraBase.
- The major means of conveying taxonomic information to CALM staff is via WACensus, in which names are kept current and replaced synonyms are also shown but with non-current status. The Web version of the Census (implemented by the Biological Information Systems Program) is a particularly efficient means of disseminating information, having attached descriptive and other information.
- Increasingly, online databases will be used to provide taxonomic information.
- Popular “bush book” style publications raise the public profile of the Department and increase community understanding of the flora and the need for conservation.
- Through publications and our online FloraBase system, information generated by this program is readily available to relevant CALM land managers, ecologists and also to our many volunteers who may alert us to populations of rare and endangered taxa, new species, extensions of range, and other novelties.
- Similarly, information is also made available to scientists and managers of other government departments, to the public at large and to the many wildflower enthusiasts.

Partnerships / Collaborators

In pursuit of its objectives this program will enter into collaborative arrangements with the following organisations:

- Australian and overseas herbaria, especially in the UK and France
- University of Western Australia
- Regional herbaria
- Australian Biological Resources Study (Environment Australia)

Staff
CC 556 WA Herbarium
PROGRAM 2 Biosystematics W A Flora

Name	Position	Level		FTE	**2.1 DRF & Priority taxa**	**2.2 Conservation status of native taxa**	**2.3 Weed Taxon biosecurity incursion monitor**
N Marchant*	Group Manager	8	3	1	0	0.1	0.1
N Lander	Pr.Research Sc	7	3	1	0.1	0.1	
J Wheeler*	Sr Research Sc	6	4	1	0.2	0.7	
T Macfarlane*	Sr Research Sc	6	4	1	0.2	0.6	0.1
B Rye*	Sr Research Sc	6	4	0.5	0.5		
A Chapman	Research Sc	4	3	1	0.2	0.7	
R Cranfield	Sr Technical Off	4	3	1	0.2	0.7	
B Mahon	Librarian	4	3	0.8			0.4
Sub Total: CRF				18.5	1.4	2.9	0.6
	Program Total Staff						**4.9**

Budget

CRF (sal + OH $311 645 ops costs $23 000) **Total CRF** **$335 145**

Program 3: Biological Information Systems

Program Leader: Mr Paul Gioia

Output Purchasers: Nature Conservation, Parks & Visitor Services

Key Result Area
The Program develops and maintains information systems such as FloraBase and its underlying databases that store and present biosystematic information from Program 2 and reflects the specimen material curated in the collection under Program 1.

This Program contributes to the Nature Conservation Output Strategic Plan objectives of '*An understanding of our State's natural biodiversity and biodiversity conservation needs*'.

Description
The Program develops, manages and extends CALM's corporate information systems for the benefit of conservation. These systems include the comprehensive list of all current and obsolete plant names (WACensus), a record of all herbarium specimens (WAHerb), and a descriptive database of WA plants (WAFlora). Together, these databases provide comprehensive knowledge of the plant species of Western Australia, their distribution and their ecological attributes. Information from them is drawn together and integrated in FloraBase, an online identification and information retrieval system. In this way a wide range of conservation activities, research and field survey work is supported.

This Program has two functions. One concerns the development, extension and management of CALM corporate botanical databases as well as a number of tools necessary for their support. The other concerns Information Systems Administration, which provides the necessary LAN infrastructure to support the communication objectives of the **Science Division**.

A number of Core Functions are shared between the 3 Programs. The Bio-information systems components are as follows:-

<u>WACensus</u>
The project entails the design, development and maintenance of the database and related procedures to enable the management of taxonomic and nomenclatural changes to WA plant names. It is also a basic component for a number of related datasets within CALM such as Wildlife Branches DRF database and

CALM**Science's** WAHerb specimen database, as well as the species master list for databases developed using the MAX database utility.

Methods will be developed such that this data will contribute to the compilation of the Australian Plant Names Index and through this to the international Plant Names Project, a joint initiative of the ANBG, Kew and Harvard.

WAHerb
The project entails the design, development and maintenance of the specimen database (spatial, phenological, population & habitat data) and procedures, which enable the management of the curation, movement and storage of the collection. It also forms the core of the Regional Information Network where community-based Regional Herbaria contribute duplicate collections to the state herbarium in return for maintenance of the specimens' identity in both collections. With data storage and maintenance procedures in place, focus has turned to developing methods for making quality information available for a broad range of research and management uses within CALM.

WAGenera
Development of a taxonomic database of Angiosperm (flowering plant) genera for WA, designed for interactive identification and information retrieval. Information from this system will form an integral part of WAFlora and FloraBase.

WAFlora
This project entails the design, development and maintenance of descriptive data for families, genera, species found in WA. The DELTA methodology has employed in order that this data can be used to generate descriptions and interactive identification tools for use in FloraBase and other applications.

WAWeeds
The design, development and maintenance of a database of biological attributes of WA alien taxa. This is forms an integral part of the Weed Information Network project (Program 1) and will become part of a Weed Information module of WABiota.

WABiota
Warehousing of a range of datasets in a single GIS environment. The data will be organized to facilitate their extraction for use within specialized collaborative projects such as Fire Decision Support Systems or Disease Management Systems. It is anticipated that funding for this project will be partly assisted by these collaborative ventures. The system will also display a range of themes based on the outcomes of associated projects and deliver these outputs through GIS applications which will be visible on the intranet and, possibly, the internet.

FloraBase
Design, development and maintenance of an interactive web site integrating information from a number of corporate data sets. There are technical, security, and design issues to be dealt with. FloraBase is widely used by some 2,000 CALM staff, consultants, tertiary institutions, school, nurseries and members of the general community. It currently services ca 100 enquiries per hour without cease. It is thus the public face of the WA Herbarium.

DELTA Integrator
The adoption of the DELTA methodology at the WA Herbarium has demonstrated the need to manage taxonomic projects and their associated data within an institutional framework. To do this requires a change in emphasis, from a project-oriented approach to a more global institutional one.

This project will develop a database 'engine', which integrates manages taxonomic descriptive data coded in DELTA from a number of studies in the Biosystematics Program. The database engine may be viewed as an *institutional complement* to the existing DELTA system that effectively transforms project oriented systems into a holistic institutional one. A built-in translator will provide the interface with the available DELTA tools by allowing data to pass smoothly between the DELTA projects and the database engine using standard DELTA formatted ASCII files, thus making it available to a range of corporate information systems. The database engine will provide the mechanism for intelligent data input, project and character list management, incorporation of changes to data in associated fundamental data sets, error and exception reporting, data editing and other database management facilities. It will provide the mechanism for manipulating data across projects while, within projects, it allows views based on partial character selection.

Max

Max is a species editing program that builds on and takes advantage of the WA Herbarium's information systems. Max allows users to maintain species-based databases by ensuring species nomenclature is up to date. This helps prevent species databases from becoming obsolete through the effects of taxonomic name changes. Max also provides users with an electronic collecting book compatible with WAHerb. This allows users to enter specimen details, print labels and upload data directly into WAHerb.

Science Division LAN Administration

This function involves the establishment, maintenance and continued upgrading of a network for electronic communications for **Science** Division. This involves the oversight of the Science Division LAN and administration of a budget, though the physical maintenance is performed by IMB through a service level agreement.

Objectives

- Develop and maintain the information systems of the Herbarium to efficiently manage our biological inventory, particularly the Specimen, Descriptive and Census databases
- Enhance the value of Herbarium-based databases to ecological research through the detection of poorly collected areas or taxa, and the identification and correction of outliers
- Disseminate biological information through the implementation of a range of delivery mechanisms, across hardware and software platforms and geographical locations
- Develop new and/or improved information systems methods and tools for managing, presenting and analysing biodiversity data.
- Ensure the integration of WA Herbarium information systems to minimise duplication of effort and optimise information flow
- Collaborate with scientists on biodiversity analyses based on Herbarium databases
- Liaise and integrate with other groups within CALM and appropriate external organisations, to allow for exchange of research findings, ideas, data, software and other products
- Raise and maintain standards of data collection and analysis and to ensure efficient database design, information management and analysis in the Division.
- Oversee, maintain and develop the LAN infrastructure for **Science** Division

Significance and Benefits

- The Program will develop the platforms and systems for the management, integration and delivery of current and reliable information (descriptive, nomenclatural, spatial, ecological, biological) on the biota of Western Australia to all CALM staff that have need of them. It will contribute informing layers to corporate decision systems. It will greatly facilitate the identification of species and the efficient retrieval of information about them. Thus it will provide a basic resource for a broad range of research, conservation and management projects.
- The Program is responsible for the provision and management of LANs at Woodvale Research Centre, **Science** Division Herbarium Research Centre/Como Research Centre, Busselton Research Centre and Manjimup Research Centre. LANs provide a central component in the Division's communication strategy as well as giving access to the Intranet and Internet and facilitating correspondence with co-researchers and clients worldwide. This Program therefore provides essential and fundamental support to all Research Projects and Service work carried out by the Division.

Targets / Results Expected

- Database label data for 0.55 million vascular plant specimens (approximately 40 specimens per taxon).
- Identify top geographical gaps in collection (eg Pilbara, Collie Basin) and liaise with Regional Herbarium Project to target these areas
- Identify gross outliers in WAHerb (~ 490,000 records) and validate geocode and species identification
- Update WACensus to incorporate non-vascular plants
- Update WACensus to support a GUI interface
- Produced predicted distribution maps of all 12,000 WA vascular plant taxa to be included in FloraBase and WABiota
- Upgrade **Science** Division LAN infrastructure to support 100Mb Ethernet
- Liaise with IMB to upgrade all **Science** Division LAN servers to migrate from Banyan Vines to Microsoft Exchange

Tasks / Activities

Program 3 tasks are listed below. Most tasks/Activities relate to Core Functions that are the key activities of all three Programs. Key activities of the Program in the Group

Core Function / SPP	Tasks / Activities	Milestones	Outputs
WAHerb : Databasing and Publication of WA Herbarium Specimen Information	• Database incoming specimen label information and update name changes / label information as required • Management of incoming and outgoing loan material • Full adoption of HISPID data exchange with all incoming and outgoing exchange material • Further develop intranet web interface for integration with CALM's NatureBase web site and controlled presentation of specimen data to national and international research associates. • Automated data output for warehousing in WABIOTA biological database. • Development of web interface for direct integration with end user GIS front ends such as WABiota. • Update WAHerb insertion form and database to support new GDA datum	03/01 • GDA compliance 03/01 • All outgoing exchange and loan material accompanied by a HISPID 3 compliant data file. 12/01 • Insertion of 25,000 records in WAHerb	• Corporate database for plant identification, fieldwork and conservation information, in collaboration with the State Collection and Biosystematics Programs. • Data source for FloraBase • Data source for GIS applications • Servicing of data requests from CALM staff and external consultants
WACensus: The Census of Western Australian Plants (SPP 93/14)	• Track changes to names in literature and through Herbarium processes • Database name changes in line with Herbarium protocols • Export WACensus data to various systems, eg FloraBase, GIS maps, Max, DEFL • Maintain/update WACensus system • Generate periodic hardcopy of Census	06/01 • Addition of lichen names to census 06/01 • Hardcopy of census 12/01 • Addition of fungi names to census 12/01 • Migration of WACensus to GUI environment • Insertion and editing of at least 400 names in census	• Species names support for Herbarium IT systems • Names distribution to Max clients, FloraBase, DEFL, etc • Printed / online census • Hardcopy of census

Core Function / SPP	Tasks / Activities	Milestones	Outputs
FloraBase	• Continued streamlining of dataset integration • Completion/implementation of FloraBase Review Action items • Development of enhanced registration system • Addition of further data sets and images • Integration with mapping component of WABiota	03/01 • Implementation of new registration system 05/01 • Addition of generic and family descriptions from the WAGenera project 06/01 • Launch of FloraBase version 2	• Current authoritative information on plant names for WA flora • Accessible and up-to-date descriptive, distributional and graphical information on WA flora • Querying of specimen vouchers documenting 200 years of botanical research in WA • Interactive identification online
WABiota	• Solicit funding for SDE and support for GIS FTE • Web development • Program development • Data uptake for species data warehouse • Development of WABiota data model	06/01 • Obtain funding for WABiota/SDE 09/01 • Update WABiota interface to include authentication (subject to funding) 12/01 • Integrate with FloraBase 06/02 • Add major Wildlife Research datasets to WABiota	• Real-time GIS querying capability over the web • Capacity to answer “where is what?” and “what is where?” for flora and fauna from vouchered and unvouchered sources • Hardcopy maps for incorporation in reports • Species lists for reserves, shires, etc
WAFlora	• Use of DELTA software and integrator to accumulate descriptive data • Liaison with other Program members to ensure integration and currency with other databases	06/01 • Integrate E-Flora data with FloraBase to ensure synchronisation between textual, spatial and image data	• Increased capacity to query species on descriptive characters
Max: Development of a species editing utility and electronic collecting book	• Supervise software developer • Liaise with Max users to solicit feedback and modify Max development accordingly • Liaise with WAHerb support to improve integration between Max and WAHerb • Plan future directions for Max • Liaise with other Herbaria to obtain censuses for other states to incorporate in Max • Explore possible incorporation of Max in CSIRO’s BioLink software suite	03/01 • Beta test Max 2 06/01 • Release production version of Max Version 2	• A tool for managing name changes in species databases • A collecting book for use by CALM staff, Regional Herbarium participants and commercial companies
DELTA Database Engine (SPP 96/13)	• Review the DELTA descriptive language and associated softwares. • Review CALM's DELTA projects. • Define and specify the Institutional DELTA Engine. • Decide on the hardware and software platform for installation. • Write program for DELTA Database Engine application. • Develop protocols for managing descriptive data at the institutional level. • Develop and test the system. Implement the system	03/01 • Finalise evaluation of specimen level DELTA scoring. Develop protocols and system if Specimen level scoring is needed. 03/01 • Beta Test DELTA Integrator 06/01 • Release Prod Version of DELTA Integrator 06/01 • Uptake and integration of E-Flora data with FloraBase 06/01 • Conduct User training	• A tool for managing Taxonomic Descriptive Data at the corporate level. • A tool for managing taxonomic and name changes to Descriptive Data • Generation of FloraBase data and its integration with WAHerb and WACensus. • Management of E-Flora data and its integration into FloraBase. • Capacity for generating exception reports for the Descriptive Data

Core Function / SPP	Tasks / Activities	Milestones	Outputs
	and conversion of existing DELTA projects into the institutional framework. • Provide user education and documentation.	09/01 • User Manual 09/01 • Integration of FloraBase II data with WACensus and WAHerb	
Science Division LAN Administration	• Maintenance and update of LAN standards and specifications in Science Division in liaison with IMB. • Installation of equipment and software. • Ongoing maintenance and upgrading of equipment and software. • Technology Watch. • Liaison with CALM's Executive IT Management Committee.	03/01 • Upgrade server and wiring at Herbarium 09/01 • Upgrade server and wiring at Woodvale 06/02 • Upgrade server and wiring at Como Research	• Migration of all Science Division servers from Banyan Vines to Microsoft Exchange • Continued functioning of Science Division LAN • Substantially increased throughput • Substantially increased server disk capacity

Performance Indicators

- Number of specimens databased and incorporated into the State Collection
- Number of specimens incorporated that satisfy taxonomic, geographic and temporal lacunae
- The number of threatened flora locations documented
- Number of specimens received from regional herbaria according to protocols established for the Regional Herbarium Project
- Number of regional based volunteer collectors
- Number of weed species correctly named in the databases system
- Number of new weed populations located and documented
- Number of local government areas for which known weed populations are listed and located
- The total amount of Departmental income derived from bioprospecting

Outcomes

- Improved dissemination of scientific knowledge aiding recognition and management of WA biota by CALM staff and the general public (publications, CALMWeb, NatureBase, CD-ROM, etc.)
- Gains in the efficiency and quality of identification of WA flora and pathogen species by CALM staff and FloraBase users
- Integration of descriptive, specimen, nomenclatural and image data with related corporate databases so that data and activities are not duplicated, systems more effectively managed and productivity increased
- More accurate and efficient management of conservation flora populations. through the rapid dissemination of accurate and timely knowledge about those populations over online media
- Development of repository for taxon-based biological data concerning distribution, fire response, *Phytophthora* sensitivity, pollination, rooting systems, horticulture, essential oils, weed behaviour, pharmaceutical activity, etc., thus providing CALM with a basis for negotiation with industry partners exploiting WA plant species for commercial benefit
- Improved decision support systems (eg RFA, Salinity Action Plan, CALM Fire, reserve acquisition, disturbance impact assessment) through the provision of fundamental informing layers
- Improved basis for the development of species and ecological community models through improved information on species identification and geographic location
- Raised public profile of Departmental role in documenting and managing the WA biota and the CALM estate through online systems such as FloraBase

Adoption/Uptake Strategy:

- Liaison with CALM's Executive IT Management Committee and Information Management Branch to represent **Science** Division's interests and be appraised of IT implications for the Division
- Through increased liaison between the Herbarium and CALM staff, the WA Museum, consultants and other contributors / maintainers of WA species data a) increased awareness of the role of the census

as a fundamental dataset underpinning science and conservation efforts within CALM and the state; b) increased consultation of the WACENSUS database during survey and research projects, and c) increased use of the WACENSUS database in species and ecological community research, management and operations projects and procedures

- Broad dissemination of the information aiding recognition of the states' Flora via publication of books, interactive CDs and web pages, and derivative publications.

Partnerships/Collaborators

In pursuit of its objectives this program will enter into collaborative arrangements with the following organisations:

- Corporate Services Division Information Management Branch and Geographic Information Services Section
- Department of Environmental Protection
- WA Museum
- University of WA
- Other WA tertiary institutions
- Other herbaria

Staff

Cost Centre 556

Name	Position	Level		FTE	3.1	3.1.1	3.1.2	3.1.3	3.1.4	3.1.5	3.1.6	3.1.7	3.1.8	3.2	3.3	3.4
N Lander	Pr. Research Sc	7	3	1	0.2											0.1
M Choo*	Sr Research Sc	6	4	1	0.2			0.6								0.4
T Macfarlane*	Sr Research Sc	6	4	1					0.1							
P Gioia*	Research Sc	6	1	1		0.1	0.1		0.1	0.1				0.4	0.1	0.1
M Yung*	Research Sc	5	4	1												1
A Chapman	Research Sc	4	3	1	0.1											
B Mahon	Librarian	4	3	0.8									0.2			
B Richardson	Sr Tech Off	4	3	0.7	0.5						0.1					0.1
A Spooner	Technical Off	2	5	0.3				0.3								
S Carroll	Database Mgr	3	4	1		0.2	0.3									
Sub Total: CRF				18.5	1	0.3	0.4	0.5	0.2	0.1	0.1		0.2	0.4	0.1	1.9
Program	Total Staff											**5.2**				

Legend

3.1 FloraBase	3.1.1 WACENSUS	3.1.2 WAHERB
3.1.3 DELTA (E-flora)	3.1.4 WAGENERA	3.1.5 Spatial Data
3.1.6 Plant Images Dbase	3.1.7 Weed Sp Dbase	3.1.8 Tax Lit Dbase
3.2 WABIOTA	3.3 MAX	3.4 Divisional LAN

Budget

CRF (sal + OH $192 160 ops costs $30 000)	**Total CRF**	**$$222 160**
Ext (0.1 FTE Sal + OH $3525	Total cost	$225 685
Divisional LAN Support		
CRF (Sal + OH $119 350 ops costs $77 000)	**Total CRF**	**$196 350**

Group Support

CC 556 WA Herbarium
PROGRAM SUPPORT

Name	Position	Level		FTE	**Admin**	**Library**
N Marchant*	Group Manager	8	3	1	0.7	
N Lander	Pr.Research Sc	7	3	1	0.5	
C S Fang	Collections Mgr	5	4	1	0.2	
B Mahon	Librarian	4	3	0.8		0.2
B Crane	Admin Off	3	2	1	1	
P Spencer	Technical Off	3	4	1	0.5	
M Mawkes	Clerical Officer	1	14	0.6	0.6	
A Walker	Clerical Officer	1	14	0.4	0.4	
CRF				18.5	**3.9**	**0.2**
	Program Total Staff					**4.1**

Budget:
CRF (Sal + OH $248 385 ops costs $90 950 **Total CRF $339 335**
(Library Sal + OH $10 600 ops costs $14 100 included above)

BIODIVERSITY CONSERVATION GROUP

KEY SCIENCE THEME: *Protection and conservation of Western Australia's biological diversity.* **Science Division** will provide knowledge of threatened species, communities and ecosystems. It will continue to identify processes and organisms that threaten the State's biological diversity and develop scientifically sound applied technologies to ameliorate these threats. Systematic biological surveys of the State will be ongoing to provide the basis for a comprehensive, adequate and representative reserve system. The impact of major ecological disturbances such salinity, wildfire and flooding will also be assessed and protocols developed for their management.

AIM: To provide a scientific basis for the protection and enhancement of the State's biological diversity, and for the establishment of a comprehensive, adequate and representative reserve system.

PROGRAMS:
Fauna recovery and conservation
Flora recovery and conservation
Disturbance ecology and management
Biological survey and reserve system

RELEVANT CORPORATE OBJECTIVE:
To protect, conserve and, where possible, restore Western Australia's natural biodiversity.
To develop community awareness and appreciation of the biological and physical diversity natural to Western Australia and promote community involvement in and support for its protection, conservation and restoration.

RELEVANT CORPORATE STRATEGIES:
Expand and improve the marine and terrestrial conservation reserve system to achieve world's best standards.
Promote off-reserve conservation that complements the reserve system.
Recover threatened flora, fauna and ecological communities.
Protect biodiversity from threatening processes, agents and activities, including feral animals, weeds, dieback, and other exotic diseases, salinity and inappropriate fire regimes.
Improve community knowledge of biodiversity conservation issues and awareness, understanding and support for CALM's activities, services and policies.
Be responsive to the community.
Partner with agencies and groups with similar interests.

PURCHASER REQUIRING SERVICE:
Nature Conservation

Program 1: Fauna recovery and conservation

Program Leader: Dr Nicola Marlow

Output Purchaser: Nature Conservation

Key Result Area:
Recovery of threatened species and communities and amelioration of threatening processes.

Description:
This program contributes to the successful recovery of threatened species and ecological communities,

while also preventing additional species or communities becoming threatened or any species becoming extinct as a result of human action / inaction.

Many species of vertebrate fauna have declined or become extinct in Australia. Western Australia supports approximately 50 percent of Australia's threatened mammals, as well as many threatened birds, reptiles, frogs and fishes. At least 38 taxa of invertebrates are also regarded as threatened. The Fauna Conservation Program provides a scientific basis for management prescriptions relating to the conservation of threatened fauna. It also identifies and develops management protocols for the major threatening processes for vertebrate fauna conservation – control of fox and feral cat predation – as well as other threatening processes. The program consists of science plans involving survey, ecological research and determination of status of threatened vertebrates, research on translocation methods, and research into efficient predator control methods that minimise or eliminate non-target effects. It also comprises research that is undertaken to understand and manage marine species such as turtles, dugongs and seabirds. Most science plans focus on single species conservation, with priorities for research being set by the Threatened Species Scientific Committee. As resources become available, more effort will be directed towards threatened invertebrate ecology and conservation.

Objectives:

- Develop the techniques required for the conservation of threatened fauna in Western Australia.
- Assist in the preparation and implementation of recovery plans, and interim recovery plans for threatened fauna taxa, focusing on the most critically endangered.
- Provide up to date information on the conservation status of threatened vertebrates and invertebrates, make recommendations on their listing and de-listing, and contribute to the ranking of threatened taxa for conservation priority, including research.
- Develop efficient and cost effective methods for controlling foxes and feral cats in Western Australia by:
    - refining existing fox control methodologies;
    - developing alternative strategies/techniques for fox control;
    - determining if, where and when cat control is required;
    - developing cat control techniques and regimes and
    - investigating possible non-target effects of fox and cat control.
- Identify other processes that may detrimentally impact on threatened fauna and develop strategies to control these processes.
- As resources permit, develop projects that aim to identify and conserve threatened invertebrates.
- Understand and promote regional conservation of marine vertebrates other than fish (especially turtles and dugong) and their habitats in Western Australia.
- Improve environmental management practices of industries and other focal activities affecting the tropical coastal waters and associated coastal habitats occupied by marine turtle and dugong.

Significance and Benefits:

Research undertaken within this program underpins the *Western Shield* fauna recovery program. The program provides the information required to successfully implement broadscale fox control program, and to successfully translocate threatened species. It also provides information on the ecology, status and threats to threatened fauna (vertebrate and invertebrate) and this is used in the preparation of Recovery Plans and in assessing the impact of management actions.

While broadscale fox control has been underway for several years, research in this program has been directed towards determining more cost-effective fox baiting methods. Research has included examining the effectiveness of different baiting frequencies, the use of immunocontraception as an alternative control method on off reserve areas, and the effectiveness of cheaper fox baits. The lack of a suitable feral cat control method has restricted *Western Shield* to the south west of WA. Within 3-5 years an effective cat control strategy will be developed and *Western Shield* will be able to be expanded to arid parts of the State, leading to the conservation of a range of arid zone mammals.

Apart from the increase in conservation status of species targeted, reconstruction of the vertebrate fauna will restore ecological processes dependent upon their presence (e.g. increased digging of soil by woylie and bandicoots). The program will benefit biological communities immensely, but the benefits to the human community flowing from a new access to Australian animals cannot be overstated. Massive educational and eco-tourism opportunities will certainly result.

The marine research being undertaken within this program is essential for the acquisition and management of CALM's significant marine conservation estate (e.g. many offshore island nature

reserves and the Shark Bay World Heritage Property and Marine Park). It also provides a focus for developing and improving the environmental management planning of industry and other related activities that affect sub-tropical and tropical coastal and offshore areas of Western Australia.

Results Expected:

- Increase in knowledge of threatened taxa and of the conservation actions necessary to conserve them.
- Increase in the preparation and implementation of recovery plans for the most threatened taxa.
- Removal of species from the threatened fauna lists.
- Complete research into more cost effective "Pro Bait".
- Commence research into frequency and intensity of cat baiting.
- Identification and management of other threatening processes.

Performance Indicators:

- An increase in the number of taxa downgraded or removed from the State's threatened fauna list.
- An expansion of *Western Shield* to include the arid zone.

Tasks/Activities – Relevant Science Project Plans:

SPP No.	**Project Title**	**Key Activities**	**Milestones** (***Targets to be achieved over quarterly time frame***)	**Outputs** (***Reports, publications, seminars, field days*** **etc**)
93/0017	Database of mammal records from Australian islands	• Update database as required • Prepare manuscript on exotic predators	• June 2002: Publication of paper analysing the effects of exotic predators	• Publication: 'Effect of exotic predators on native mammals on Australian islands'.
93/0018	Seabird breeding islands database	• Update database as required • Prepare manuscript on seabirds of Houtman Abrolhos Islands	• June 2002: Publish manuscript	• Publication: 'Changes in breeding seabird populations of the Houtman Abrolhos Islands'.
93/0022	Conservation status of butterflies	• Finalise two scientific papers describing new subspecies of Western Australian butterflies. • Complete studies of the life history of the western flat, *Exomotoeca nycteris*. • Review the ecology and conservation status of Western Australian butterflies. • Prepare PhD proposal on ecology of Western Australian butterflies.	• Mar 2001: Complete draft paper describing the life history of the western flat, *Exomotoeca nycteris*. • Jun 2001: Review or resubmit draft papers describing new subspecies of Western Australian butterflies. Submit paper describing the life history of the western flat. • Sept 2001: Review or resubmit draft paper describing the life history of the western flat. • Dec 2001: Finalise draft review of the ecology and conservation status of Western Australian butterflies. • Mar 2002: Submit PhD proposal on ecology of Western Australian butterflies. • Jun 2002: Prepare SPP on ecology of Western Australian butterflies.	• A scientific paper describing a new subspecies of *Candalides hyacinthinus*. • A scientific paper describing two new subspecies of *Ogyris otanes.* • A scientific paper describing the life history of the western flat, *Exomotoeca nycteris*. • A report reviewing the distribution, conservation status and ecology of Western Australian butterflies, documenting particularly the known threats and areas where more data are needed.
93/0040	Conservation of marine turtles	• Finalise management plan. • Attract NHT funding for studies into impact of indigenous take (Broome)	• July 2001: Turtle management plan to be approved by NC output Director. • Sept 2001: Monitoring	• Publish turtle management plan. • Functional database.

		and impact of foxes and 4WD (Ningaloo). • Provide support for Regional turtle monitoring programs. • Commence research into impact of indigenous take of turtles • Maintain and upgrade database	systems established in Denham, Karratha and Broome • Oct 2001: Fully functional database • June 2002: Complete management plan for turtles	
93/0041	Dugong conservation – NW Australia	• Finalise management plan in collaboration with Wildlife Branch	• June 2002: Complete management plan for dugongs	• Publish dugong management plan.
93/0052	Conservation of the Thevenard Island Mouse	• Develop house mouse control program on Thevenard Island with Chevron. • Continue monitoring Serrurier Island TIM population. • Undertake final eradication of house mice	• Sep 2001: Eradication of house mice • June 2002: Complete publication	• Report on the eradication of House mice on Thevenard Island. • Publication: The eradication of House mice from Thevenard Island"
93/0053	Recovery plan for the Chuditch	• Close captive breeding colony at Perth Zoo • Undertake surveys at monitoring sites in the jarrah forest and wheatbelt • Analyse and publish last 10 years of research on the ecology and management of Chuditch • Write a chapter in the Dasyurid Symposium book • Write review of conservation status of Chuditch using IUCN criteria	• Jan 2001:Complete revision of Chuditch recovery case study • Aug 2001: Complete review document of Chuditch conservation status.	• Book chapter summarising most of the ecological and management work on Chuditch. • Review document on status of the Chuditch that may lead to downlisting of species.
93/0054	Effect of fox control on habitat utilisation by the mainland quokka	• Ongoing maintenance of quokka distribution database linked to GIS. • Obtain estimates of quokka abundance at selected known mainland sites. • Analyse habitat use at northern jarrah forest sites. • Develop predictive model. • Analyse data • Write up PhD. • Complete manuscripts • Prepare presentation on the effects of fox control on the habitat utilisation of quokkas • Develop quokka distribution database that is accessible to CALM Districts and regions via the CALM web through a GIS interface in read only format. • Prepare presentation on using quokka distribution database • In conjunction with Murdoch University and PAC CRC:	• Dec 2001: Complete analysis of habitat use at northern jarrah forest sites. • Dec 2001: Complete predictive model. • Dec 2001: Complete data analysis on population estimates • Dec 2001: Complete quokka distribution database • Mar 2002: Complete review of conservation status of the mainland quokka in accordance with IUCN criteria and WA criteria for listing/de-listing as a threatened species. • June 2002: Completion of a functional database on the distribution of the mainland quokka • June 2002: Deliver presentation on the effects of fox control on the habitat utilisation of quokka. (Target audience is Alcoa research group, research institutions, CALM researchers and managers). • June 2002: Present seminar on using quokka	• A report reviewing the conservation status of the quokka • A functional quokka distribution database • Presentation of a seminar on the effects of fox control on the habitat utilisation of the mainland quokka • Presentation of a seminar on the use of the quokka distribution database • PhD: 'Ecology of mainland populations of the quokka, *Setonix brachyurus*.' • Publications" • Population dynamics of the quokka in the northern jarrah forest of southwest Western Australia. • Home range and habitat use of the quokka in the northern jarrah forest of southwest Western Australia. • Diet of the quokka in the northern jarrah forest of southwest Western Australia. • Fire as a tool for management of quokka habitat in the northern jarrah

		• Determine mating system and levels of inbreeding of northern jarrah forest quokka populations; • Develop a technique to determine effective population size without the requirement of labour intensive surveys • Determine effective population size at sites from which tissue samples have been collected and corroborate/validate field collected demographic data.	distribution database • June 2002: Submit PhD: 'Ecology of mainland populations of the quokka, *Setonix brachyurus*' • June 2002: Complete paper 'Population dynamics of the quokka in the northern jarrah forest of southwest Western Australia'. • June 2002: Complete paper 'Home range and habitat use of the quokka in the northern jarrah forest of southwest Western Australia'. • June 2002: Complete paper 'Diet of the quokka in the northern jarrah forest of southwest Western Australia'. • June 2002: Complete paper 'Fire as a tool for management of quokka habitat in the northern jarrah forest of southwest Western Australia' • June 2002 Complete paper: 'An estimation of effective population size of the mainland quokka using DNA analysis of tissue samples'	forest of southwest Western Australia • An estimation of effective population size of the mainland quokka using DNA analysis of tissue samples
93/0056	Recovery plan for the Shark Bay Mouse	• Monitor Bernier Island population. • Monitor Doole Island population. • Continue monitoring North West Island translocated population. • Close down captive breeding colony Perth Zoo. • Write Progress report for management team • Write publication on the ecology of the SBM	• June 2002: Complete monitoring Bernier Island population • June 2001: Complete monitoring Doole Island population. • June 2002: Complete progress report • June 2002: Complete manuscript on ecology of the SBM	• Progress report on SBM monitoring to recovery team. • Publication on the ecology of SBM on Bernier Island.
93/0063	Western Swamp Tortoise recovery plan	• Maintain captive breeding colony at Perth Zoo • Monitor translocated populations at Ellen Brook and Twin Swamps NR. • Translocate to a third site in the Mogumber area. • Write progress report for Recovery team	• Feb 2001: Complete annual report to Western Swamp Tortoise recovery team • Feb 2002: Complete annual report to Western Swamp Tortoise recovery team	• Recovery Team annual reports
93/0065	Conservation of the Western Bristlebird	• Complete mid-term review of Research Plan • Monitor translocated population in Walpole – Nornalup NP and assess options for further translocations • Assess response to fire in Fitzgerald River NP • Complete review for recovery team • Write report/	• Mar 2001: Draft review circulated to recovery team • June 2001: Finalisation of review • Dec 2001: Complete post-fire monitoring at Fitzgerald River NP • Complete monitoring of translocated population at Walpole-Nornalup NP • Mar 2002: Complete analysis of monitoring data	• Report to WBB recovery team • Report/publication on effects of fire on bristlebirds • A talk/seminar presented to local community at Walpole

		publication on the effects of fire on bristlebirds	• June 2002: Complete report of monitoring of WBB for recovery team • June 2002: Complete report on effects of fire on bristlebird • June 2002: Deliver a talk/seminar to local community at Walpole	
93/0066	Radio tracking of translocated Noisy Scrub-birds	• Summarise data collected to date • Prepare report to Recovery team	• Dec 2001: Complete report to Recovery Team	• Recovery Team Report (possible publication depending on findings)
93/0071	Monitoring numbers of Lesser Noddies and other seabirds on Pelsaert Island.	• Annual monitoring trips in association with Fisheries WA	• June 2002: Publish manuscript	• Publication: 'Changes in breeding seabird populations of the Houtman Abrolhos Islands'.
93/0093	Conservation of threatened frogs	• Monitor *Geocrinia lutea* sites Oct/Nov each year • Model effects of fire • Prepare report for recovery team	• Dec 2001: Complete report for recovery team	• Recovery team Report.
93/0142	Conservation of the western ringtail possum	• Ongoing maintenance of western ringtail possum distribution database linked to GIS. • Develop western ringtail possum distribution database that is accessible to CALM Districts and regions via the CALM web through a GIS interface in read only format. • Complete western ringtail possum conservation status review. • Complete Leschenault and Yalgorup National Park translocation monitoring. • Analyse data from Leschenault, Yalgorup and Lane Poole proposals with the potential to modify or destroy western ringtail possum habitat • the recommended management option for the survey, translocations. • Assess the genetic status of the western ringtail possum and determine if it constitutes a separate ESU from *P. peregrinus*. • Determine the number of recognisable Management Units for the western ringtail possum. • Assess whether effective population size can be determined for the western ringtail possum	• Dec 2001: Meet with management team to resolve identified issues • March 2001: Deliver two presentations to the local communities in the vicinity of Yalgorup National Park on the conservation status of the western ringtail possum, translocation success and the benefits of fox control • March 2001: Complete review of conservation status of the western ringtail possum in accordance with IUCN criteria and WA criteria for listing/de-listing as a threatened species. • Dec 2001: Complete translocation data analysis • Mar 2002: Complete genetic status analysis • June 2002: Completion of a functional database on the distribution of the western ringtail possum • June 2002: Complete paper Conservation management of the western ringtail possum 1: Review of distribution and conservation status • June 2002: Complete paper Conservation management of the western ringtail possum 2: Translocation of rehabilitated possums • June 2002: Complete paper Conservation management of the western	• Presentation of a two seminars on the effects of fox control on the conservation status of the western ringtail possum • A report reviewing the conservation status of the western ringtail possum • A functional database on the distribution of the western ringtail possum • Publish: • Conservation management of the western ringtail possum 1: Review of distribution and conservation status • Conservation management of the western ringtail possum 2: Translocation of rehabilitated possums • Conservation management of the western ringtail possum 3: Home range and habitat use of the western ringtail possum at jarrah forest translocation release sites. • Use of Ketamine and Xylazine for immobilisation of the western ringtail possum and the brush-tailed bettong • A new tranquilliser dart gun for capture of small to medium sized arboreal marsupials • An estimation of effective population size of the western ringtail possum using DNA analysis of tissue

		(using highly variable microsatellite markers) and corroborate/validate field survey demographic data. • Prepare manuscripts for publication • Liaise with western ringtail possum recovery team members to resolve issues concerning: • release of rehabilitated possums; and • development capture and relocation of WRPs when resources for these translocations are unavailable to managers.	ringtail possum 3: Home range and habitat use of the western ringtail possum at jarrah forest translocation release sites. • June 2002: Complete paper Use of Ketamine and Xylazine for immobilisation of the western ringtail possum and the brush-tailed bettong • June 2002: Complete paper A new tranquilliser dart gun for capture of small to medium sized arboreal marsupials • June 2002: Complete paper An estimation of effective population size of the western ringtail possum using DNA analysis of tissue samples	samples
93/0144	Quenda translocation methods	• Complete monitoring program at Dongolocking • Write manuscript	• June 2002: Complete paper on 'Population growth in translocated quenda populations under fox control'	• Publication: 'Population growth in translocated quenda populations under fox control'
93/0145	Factors affecting establishment in the numbat reintroduction program	• Continue monitoring radio-collared animals in Stirling Range and Hills Forest reintroductions. • Establish diggings survey monitoring regime at Karroun Hill and Dragon Rocks. • Continue monitoring by driven survey at Dryandra, Boyagin and Tutanning • Continue monitoring diggings at Boyagin and Batalling • Write review paper on numbat translocations • Prepare talk to Dryandra Woodland Ecology course • Write Landscope article on numbat recovery	• February 2000: Complete review paper on numbat translocations • March 2001:submit review of numbat conservation status, • June 2001: Complete annual report to recovery team • June 2002: Complete annual report to recovery team. • June 2002: Landscope article on numbat recovery • June 2002: Deliver presentation to Dryandra Woodland Ecology Course	• Review paper on numbat translocations. • Report on the conservation status of the numbat. • Annual reports of recovery team, January 2001 and 2002, • Public talk to Dryandra Woodland Ecology Course • Landscope article on numbat recovery • Field day for SRNP neighbours
93/0149	An assessment of the effect of fox control on Red-tailed Phascogale populations	• Finish habitat attribute assessment with ATCV. • Write paper on effect of fox control on red-tailed phascogale populations	• Sept 2001: Write paper on The effect of fox control on *P. calura*. • June 2002: Landscope article on the effect of fox control of populations of the red-tailed phascogale • June 2002: Deliver presentation on recovery of the red-tailed phascogale	• Publication: The effect of fox control on *P. calura* • Public talk on red-tailed phascogales • Landscope article on red-tailed phascogales
93/0157	Control and ecology of the red fox in WA	• Analyse operation foxglove trapping data. • Analyse operation foxglove vegetation / habitat data. • Analyse operation foxglove brushtail possum den tree use data • Analyse operation foxglove woylie	• June 2001: Complete trapping data analysis. • June 2001: Complete vegetation / habitat analysis. • June 2001: Complete brushtail possum den tree use data analysis • December 2001: Complete report containing guidelines on the optimal fox	• Report on the optimal fox baiting regimes for the northern jarrah forest • Report on the selection of habitat trees for brush-tailed possums • Publications: • Large scale fox control in the northern jarrah forest of southwest Western

		survivorship data. • Prepare guidelines for optimal fox baiting regimes in the forest. • Prepare guidelines for habitat tree selection • Prepare publications.	baiting regimes for the northern jarrah forest • December 2001: Complete report containing guidelines for the selection of habitat trees for brush-tailed possums • June 2002: Complete paper: Large scale fox control in the northern jarrah forest of southwest Western Australia 1: Survivorship of translocated populations of the woylie and implications for operational 1080 baiting programs • June 2002:Complete paper: Large scale fox control in the northern jarrah forest of southwest Western Australia 2: Native fauna response to different levels of fox density reduction • June 2002:Complete paper: Survivorship and habitat use of the common brushtail possum in 1080 baited and unbaited sites in the northern jarrah forest of south west Western Australia' • June 2002:Completion paper: Use of den trees by the common brushtail possum in the northern jarrah forest of south west Western Australia	Australia 1: Survivorship of translocated populations of the woylie and implications for operational 1080 baiting programs • Large scale fox control in the northern jarrah forest of southwest Western Australia 2: Native fauna response to different levels of fox density reduction • Survivorship and habitat use of the common brushtail possum in 1080 baited and unbaited sites in the northern jarrah forest of south west Western Australia' • Use of den trees by the common brushtail possum in the northern jarrah forest of south west Western Australia.
93/0159	Ecology and conservation of WA pythons	• Diet analysis of carpet pythons from insular and mainland populations. • Continuation of mark-recapture study on Garden and West Wallabi Islands to collect further data on time to maturity, ontogenetic shifts in prey selection, growth rates and mortality. • Completion of necropsy and faecal pellet analysis work • Analysis of home range, reproduction, activity and thermoregulation data and its publication	• June 2001: Report to Dept Defence • Mar 2001: Submission of manuscript to *Copeia* on the ability of carpet pythons to excrete transmitters. • June 2001: Completion of necropsy and faecal pellet analysis work • Sept 2001: Completion of manuscript on home range and activity in pythons • Dec 2001: Completion of manuscript on life history attributes of pythons. • Mar 2002: Complete manuscript thermoregulation in pythons • June 2002: Completion of manuscript on St Francis Island pythons.	• Annual report of activities on Garden Island to Dept of Defence. • Manuscript on the expulsion of implanted transmitters in pythons to *Copeia*. • Manuscript on home range and activity patterns of pythons. • Manuscript on life history attributes of pythons. • Manuscript on thermoregulation in pythons. • Manuscript on the pythons of St Francis Island.
93/0163	Genetics and ecology of the Western Barred Bandicoot	• Write paper on home range at White Beach, Dorre Island. • Analyse results of cross-breeding experiment and write up. • Through collaborative work determine cause of infection detected in captive breeding colonies	• March 2001: Complete paper on WBB home range. • June 2001: Complete paper on cross-breeding in WBBs • June 2002: Complete Landscope article on WBBs	• Manuscript on home-ranges of WBBs • Manuscript on cross breeding in WBBs • Landscope article on WBBs.

		and Bernier Island animals.		
95/0005	Conservation strategy for the western desert rock-wallaby	• Continue monitoring and fox control at Calvert Range. • Obtain funding for translocation, external funding if possible • Translocate to a secure Pilbara island.	• Nov 2001Translocation to secure Pilbara island (subject to availability of funding) • Jun 2002: Complete report on translocation	• Report on translocation of the western desert rock wallaby
95/0011	Status and ecology of the Dibbler in WA	• Commence survey in Torndirrup NP • Commence survey in Cape Arid NP • Support dibbler monitoring trips to Boullanger Whitlock and Escape Is • Continue monitoring Escape Island translocated population. • Continue monitoring Boullanger / Whitlock Island populations. • Continue survey of south coast. • Continue monitoring population in Fitzgerald River NP • Continue ecological research on dibblers in FRNP. • Continue to support captive breeding of mainland animals for translocation. • Establish further mainland dibblers in PZ colony and begin captive breeding • Survey Peniup and Corackerup NRs for dibblers • Carry out translocation of dibblers to Peniup/Corackerup • Write Landscope article • Write annual reports to recovery team • Write manuscript on dibblers in FRNP	• Mar 2001: Complete translocation proposal for a mainland translocation • June 2001: Complete annual report to recovery team • June 2001: Present seminar on dibbler recovery • June 2002: Complete manuscript on dibblers in FRNP • June 2002: Complete Landscope article on dibblers • June 2002: Complete annual report to recovery team	• Two annual reports to the recovery team • Publication on dibblers in the FRNP • Landscope article on dibblers • Seminar on dibbler recovery
95/0016	Experimental management and monitoring of desert rock wallaby populations	• Liaison with Ngaanyatjarra Council and CALM Goldfields to continue baiting foxes in Townsend Ridges. • Monitor rock-wallaby population to assess effectiveness of baiting. • Collection of tissue for genetic work in conjunction with Macquarie University. • Continue to monitor rock-wallabies and provide feedback to Aboriginal contractors on the success of baiting. • Prepare Landscope	• December 2001: Completion of monitoring trip to Townsend Ridges and collection of genetic tissue • March 2002: Supply tissue for genetic work to Macquarie University: • June 2002: Workshop with CALM, Ngaanyatjarra Council about the possible expansion of baiting operations in the Central Aboriginal Reserve. • June 2002: Complete Landscope article on saving rock wallabies in the central desert	• Landscope article tentatively titled “Last Bastion: Saving rock-wallabies in the central desert”.

		article		
96/0001	Fox population dynamics	• Simulate the impact of fertility control on fox demographics. • Write manuscript	• Oct 2001: Complete manuscript on compensatory breeding in foxes •	• Manuscript: Compensatory breeding in a reduced population of red foxes in a semi-arid area of Western Australia
96/0008	Recovery of Gilbert's Potoroo	• Continue ecological studies at Two Peoples Bay • Survey Boulder Hill • Survey Green Range • Carry out regular trapping of known colonies on Mount Gardner • Continue survey for further populations • Maintain captive colony at TPB. • Establish captive colony at Perth Zoo to allow investigation of assisted reproductive technologies. • Support development of cross-fostering project • Carry out nutrient analysis of hypogeal fungi, to assist in development of captive diet • Write Landscope article • Write manuscript on home-range of Gilbert's potoroo • Write manuscript on population dynamics of Gilbert's potoroo	• June 2002: Complete nutrient analysis of hypogeal fungi • June 2002: Complete Boulder Hill survey • June 2002: Complete manuscript on home-range of Gilbert's potoroo • June 2002: Complete manuscript on population dynamics of Gilbert's potoroo • June 2002: Complete Landscope article	• Manuscript: The home-range of Gilbert's potoroo • Manuscript: The population dynamics of Gilbert's potoroo • Landscope article on Gilbert's potoroo
96/0014	Broadscale cat control – census and baiting regimes.	• Finalise bait development. • Determine optimal baiting frequency and intensity. • Achieve cat bait production • Provide protocols for cat control in the arid zone • Undertake non target trials for FST project (collaboration with DNRE and Environment Australia). • Write paper on cat control techniques	• June 2002: Complete manuscript on cat control techniques	• Publication: Cat control techniques.
97/0005	Fox and cat density estimates, survivorship, and home range estimates in the presence of 1080 baiting within the NJF – a pilot study.	• Derive estimates of fox density within the northern jarrah forest and assess validity of the technique. • Assess the suitability of conventional and satellite telemetry in the northern jarrah forest • Determine whether foxes are surviving successive 1080 baiting events and determine home range and survivorship of foxes and cats within the northern	• June 2001: Complete data analysis • June 2002: Complete publication 'Use and validation of sandplotting to derive an index to fox density' • June 2002: Complete publication 'The use of satellite telemetry to monitor movements of the red fox, *Vulpes vulpes*: a pilot study'	• Publish: • Use and validation of sandplotting to derive an index to fox density. • The use of satellite telemetry to monitor movements of the red fox, *Vulpes vulpes*: a pilot study

		jarrah forest. • Analyse data • Prepare manuscripts		
98/0005	Status, ecology and conservation of the Pilbara Olive Python	• Continue radio-telemetric study of olive pythons at 3 sites in the Pilbara. • Taxonomic and captive reproduction studies with Pilbara volunteers. • Analyse and write-up completed Pannawonica radio-tracking data. • Undertake fieldwork on Burrup Peninsula with Nickol Bay Naturalist Club • Help prepare report on Burrup work for NHT • Write manuscript on radio-telemetry at Pannawonica	• June 2001: Complete detailed telemetry during the breeding season • Sept 2001:Complete entry of taxonomic data collected to date into database • March 2002: Complete manuscript on radio-telemetry work at Pannawonica • June 2002: Complete NHT report on Burrup work in collaboration with Nickol Bay Naturalist club • June 2002: Complete manuscript on radio-telemetry at Pannawonica	• Report to NHT on Burrup work • Manuscript for Wildlife Research on radio-telemetric work at Pannawonica
98/0016	Status of the Pebble-mound Mouse	• Taxonomy liasing with van Dyck and Woinarski – ongoing • Write manuscript	• June 2002: Complete manuscript comparing mound structures of pebble mound mice species	• Paper comparing mound structure of different pebble mound mice species *(P. chapmani* and *P. laborifex*)
99/0011	Recovery plan implementation for the Lancelin Island Skink	• Carry out actions listed in published Recovery Plan. • Assess suitable sites for translocation of skinks bred at Perth Zoo. • Monitor skink population on Lancelin Island. • Write translocation proposal • Undertake translocation if approved. • Monitor translocated and Lancelin Island populations.	• Mar 2001: Complete translocation proposal and submit for review • June 2001: Undertake translocation if approved • December 2001: Monitor translocated and Lancelin Island populations. • March 2001: Monitor translocated population • June 2001: Complete a manuscript on the effect of the herbicide Fusilade on Lancelin Island Skinks	• Translocation Proposal for the Lancelin Island Skink. • Manuscript on the impact of Fusilade on Lancelin Island Skinks
99/0013	Breeding ecology and conservation of the Banded Stilt	• Monitor rain reports from Eastern Goldfields and Wheatbelt. • If exceptional rains, conduct air surveys to locate breeding colonies. • Monitor breeding success and major limiting factors. • Band and leg-flag chicks.	• Jun 2001: Complete monitoring of breeding success • Jun 2001: Complete banding of chicks • Jun 2001: Complete report on breeding success • Jun 2002: Complete monitoring of breeding success • Jun 2002: Complete banding of chicks • Jun 2002: Complete report on breeding success	• Reports on stilt breeding success and banding activity
99/0018	Determination of efficacy of the new fox bait "Probait" Phase 1	• Complete bait uptake trials. • Complete bait 1080 analyses. • Contribute to NRA registration process • Combine results of this SPP with those of SPP 2000/0014 (Probait Phase 2).	• Aug 2001: Complete field trials on Probait longevity • Nov 2001: Suitable populations of phascogales identified • Jan 2002: Deliver Probaits to a population of phascogales • June 2002: Complete report on the efficacy of	• Report: 'The uptake of Probaits by foxes • Report: The uptake of Probaits by a population of brushtail phascogales

		• Write report	Probaits • June 2002: Complete report on the uptake of Probaits by a population of brushtail phascogales	
2000/0002	Ground Parrot recovery	• Develop monitoring protocol • Analyse data from monitoring program • Write Recovery Plan - 2001 • Implement Recovery Plan where funds permit	• Mar 2001: Draft Recovery Plan circulated • Dec 2001: Recovery Plan finalised and approved • Successful implementation of relevant actions in the Recovery Plan where funds available (timing dependent on funding)	• Approved Recovery Plan • Scientific publication on post-fire monitoring • Talk presented to 'Friends' Group
2000/0014	"Probait" Phase 2.	• Determine the field longevity of Probaits • Determine potential impact of Probaits on Phascogales and other native species. • Combine results of this SPP with those of SPP 99/0018 (Probait Phase 1) to produce a report • Do pilot study to identify suitable populations of phascogales (if funding becomes available) • Write report on the uptake of Probaits by foxes • Write report on the uptake of Probaits by a population of brushtail phascogales (if funding becomes available)	• Aug 2001: Complete field trials on Probait longevity • Nov 2001: Suitable populations of phascogales identified • Jan 2002: Deliver Probaits to a population of phascogales • June 2002: Complete report on the efficacy of Probaits • June 2002: Complete report on the uptake of Probaits by a population of brushtail phascogales	• Report: 'The uptake of Probaits by foxes • Report: The uptake of Probaits by a population of brushtail phascogales
No SPP	Return to Dryandra	• Write SPP • Establish populations of 5 species in 20 ha enclosure • In conjunction with Narrogin staff carry out regular monitoring of enclosure populations • Continue to monitor reintroduced bilbies in Dryandra Woodland (outside fence) • Carry out translocation of Western Barred Bandicoots to Dryandra Woodland (outside fence) • Release another species outside the fence • Write report to Western Shield Committee • Write Landscope article • Write manuscript	• Nov 2002: Complete translocation of WBBs to Dryandra Woodland (outside fence) • Nov 2003: Complete translocation of other species to Dryandra Woodland (outside fence) • June 2002: Complete report to Western Shield committee • June 2002: Complete Landscope article • June 2002: Complete publication on bilby reintroduction	• Report to Western Shield committee • Landscope article. • Publication on bilby reintroduction • Field day involving neighbours and interested persons
No SPP	Monitoring of Barrow Island mammals	• Undertake annual monitoring trip to Barrow Island • Develop method for monitoring rock-wallabies on Barrow Island • Enter trapping data onto computer • Establish database for	• Nov 2001: Complete monitoring • Nov 2001: Complete trapping data entry • Nov 2001: Complete analysis of spotlighting data • Dec 2001: Complete report • June 2002: Complete	• Reports to Chevron and CALM.

		spotlighting data • Analyse spotlighting data. • Write reports to Chevron and CALM with recommendations about future work/requirements	reports to Chevron and CALM	
No SPP	Conservation of Mulgara and other arid zone dasyurids	• Prepare SPP and Animal Ethics proposal. • Comprehensive study of sympatric and allopatric dasyurids in the Eastern Goldfields, focusing on threatened and rare species. • Regular trapping surveys, collection of genetic material for examining sub-population structuring • Undertake radio-telemetry. • Write reports to Western mining • Write report to Mulgara recovery team	• March 2001: Complete SPP • June 2001: Complete report to Mulgara recovery team • Sept 2001: Monitor the Mulgara breeding season • Dec 2001: Complete annual report to Western Mining • Mar 2002: Monitor dispersal of Mulgara young • June 2002: Complete annual report to Western Mining	• Annual reports to Western Mining Corporation (main source of funds). • Report to Mulgara Recovery Team
No SPP	Taxonomy and ecology of the Heath Mouse	• Undertake habitat assessment. • Undertake extensive trapping in Lake Magenta NR. • Undertake genetic assessment east vs west (Peter Spencer Marsup CRC) • Undertake heath rat habitat / vegetation requirements analysis (Honours project) • Determine distribution at Lake Magenta NR. • Review conservation status after taxonomy resolved • Assess other sites for heath rats	• May 2001: Complete analysis of distribution at Lake Magenta NR • May 2001: Complete heath rat habitat / vegetation requirements analysis (Honours project) • Aug 2001: Complete review of taxonomy • June 2002: Complete assessment of other sites for the presence of heath rats • June 2002: Complete report on the distribution of heath rats in WA • June 2002: Complete report on the conservation status of the heath rat in WA	• Report on the distribution of the heath rat in WA • Report on the conservation status of heath rats in WA
WD/0042	Mont ebello islands fauna rehabilitation project	• Eradicate Black Rats (ongoing) • Monitor translocated mammal populations • Prepare Landscope article	• Sept 2001: Complete rat eradication • Sept 2001: Monitor Mala and Djoongari • June 2002: Complete manuscript on eradication • June 2002: Complete report on Mala and Djoongari translocations	• Report on rat eradication • Report on Mala and Djoongari translocations

Anticipated Outcomes:

- Removal of Western Australian faunal species from threatened species lists.
- Development of broadscale feral cat control programs in arid and semi-arid areas to reduce cat predation upon vulnerable fauna.
- Refinement of fox control programs in the southwest of WA to reduce the cost of baiting to protect vulnerable fauna from fox predation.
- Development of an effective new and cheaper fox bait to be used to reduce fox predation upon vulnerable fauna.

Adoption Strategy:

- Outcomes of research will be communicated to Nature Conservation Division and Regional Services staff through seminar series and participation in recovery teams meetings.
- Where required, program staff will assist in establishing fauna monitoring programs to ensure research developments are transferred to operational activities.
- Program members will continue to be involved in Western Shield planning and implementation groups.
- Research findings will be published as reports or in reputable journals within twelve months of data collection.

Partnerships/Collaborators:

The following organisations are partners or collaborators in the delivery of services identified in the Fauna Recovery and Conservation Program:

- NHT Endangered Species Program
- NHT Invasive Species Program
- University of WA – Zoology, Animal Science
- Murdoch University – Veterinary Clinical Science
- University of NSW
- Perth Zoo
- Marsupial Management CRC
- Pest Animal Control CRC
- Department of Commerce and Trade
- Agriculture WA
- Perth Zoo
- Kanyana Wildlife Rehabilitation Centre
- Alcoa
- Boddington Gold Mine
- Karakamia Sanctuary

Staff:

Staff	**Location**	**FTE**
D. Algar	Woodvale	1.00
A.A. Burbidge	Woodvale	0.50
A.H. Burbidge	Woodvale	0.15
P. de Tores	Woodvale	1.00
T. Friend	Albany	1.00
N. Marlow	Woodvale	1.00
K. Morris	Woodvale	0.20
D. Pearson	Woodvale	0.75
R. Prince	Woodvale	1.00
T. Start	Kununurra	0.25
M. Williams	Como	0.05
Scientist Total		**6.90**
J. Angus	Woodvale	1.00
M. Dillon	Dwellingup	1.00
P. Fuller	Woodvale	0.20
B. Johnson	Woodvale	1.00
M. Onus	Woodvale	1.00
J. Rolfe	Woodvale	1.00
N. Thomas	Woodvale	1.00
A. Williams	Woodvale	1.00
Technical Officer Total		**7.20**
Program TOTAL		**14.10**

Budget:

Salaries	$ 942 874
Overheads	$ 255 518

Operating: CF	$ 99 000
Operating: external	$ 351 300
TOTAL	**$ 1 648 692**

Program 2: Flora Recovery and Conservation

Program Leader: Dr David Coates

Output Purchaser: Nature Conservation

Key Result Area:
Recovery of threatened species and communities and amelioration of threatening processes.

Description:
This program contributes to the successful recovery of threatened species and ecological communities, while also preventing additional species or communities becoming threatened or any species becoming extinct as a result of human action / inaction.

Currently there are 334 listed threatened plant taxa in WA, of which 95 are critically endangered and many require immediate recovery action. These taxa form a major focus of this program's research which is aimed at the development of sound scientifically based management prescriptions and recovery actions for threatened flora and threatened ecological communities. Threatened taxa from a number of genera or groups are currently under investigation including: *Acacia*, *Banksia, Dryandra, Eremophila, Eucalyptus, Lambertia, Stylidium* and *Verticordia*.

The Threatened Flora Seed Centre (TFSC) is also an integral part of the Program and is responsible for the ongoing collection and storage of seed from rare and threatened flora, particularly critically endangered taxa. Its function covers not only storage but also research into seed biology and seed storage methodologies. Closely linked with this facility are experimental translocations, largely based on material from the seed store. These translocations are designed to investigate a range of re-introduction methodologies that may be suitable for critically endangered taxa and to develop protocols for assessing translocation success.

Area-based threatened and priority flora management programs have been an important focus of the program for the last ten years. Although this work is largely completed in the south-west as the Districts take over program production and / or up dating, programs for other parts of the State are planned and have commenced for the Goldfields. Survey of priority flora thought to be critically endangered continues and is now a significant focus for the Program. There are 1142 flora listed by CALM as poorly known but considered to be rare and likely to be threatened (Priority 1 and 2, CALM listing). Possibly as a many as 10%, based on current CALM estimates, are likely to be critically endangered and require urgent survey to assess conservation status before listing as threatened.

Amelioration and control of the major threatening processes, invasive weeds and *Phytophthora* root rot, in populations of threatened flora, threatened ecological communities and in areas of high conservation value are also critical research areas of this Program. The use of phosphite for the localised control of *Phytophthora* has been a significant research breakthrough. However, further work is needed to improve the application of phosphite to native vegetation and to enhance its longevity in the plant for longer-term protection.

Objectives:
- Development of sound scientifically based protocols for the conservation and recovery of rare, threatened flora and other priority flora in WA. These protocols will be based on an adequate understanding of the population dynamics, reproductive biology and population genetics of target taxa.
- Establish and maintain an *ex situ* germplasm storage facility, and develop storage technologies for rare and threatened flora.
- Develop appropriate translocation methodologies and guidelines for assessing translocation success

for threatened flora.

- Provide up to date information on the conservation status of rare and poorly known flora (priority flora), make recommendations on the annual addition of taxa to the threatened flora (Declared Rare Flora) list and assist in the ranking and prioritisation of threatened taxa for recovery.
- Identify processes (e.g weeds, *Phytophthora* root rot) that detrimentally impact on native flora particularly rare and threatened species and threatened ecological communities, and develop strategies for the amelioration and control of these processes in conjunction with habitat restoration programs.
- Provide phylogenetic and molecular systematic data that will assist in the description, classification, prioritisation and conservation of the Western Australian flora.

Significance and Benefits:

This program will deliver a sound scientific basis for the *in situ* management and recovery of threatened flora populations and populations of other flora of special interest. It will provide accurate and up to date assessments of the conservation status of threatened (Declared Rare Flora) and Priority Flora leading to their improved prioritisation and ranking for management actions. The maintenance of an *ex situ* germplasm storage facility will ensure that critical material is available for translocations of threatened species and restoration programs. A range of experimental translocations will not only be used to develop appropriate translocation methodologies and protocols for assessing translocation success, but will also result in improved rates of threatened flora recovery. The amelioration and control of threatening processes such as weeds and *Phytophthora* root rot, are critical for the successful *in situ* management of a significant proportion of threatened flora populations and threatened ecological communities. In particular the further refinement of phosphite application has the potential to lead to a significant improvement in the localised control of *Phytophthora* in populations of critically endangered plants, threatened ecological communities and other areas of high conservation value.

Results Expected:

- Removal of plant taxa from threatened species lists.
- Improved conservation status ranking of threatened flora and Priority flora
- Identification of threatening processes.
- Development of techniques to ameliorate and control threatening processes particularly weeds and *Phytophthora cinnamomi* (dieback).

Performance Indicators:

- An increase in the number of taxa downgraded or removed from the State's threatened flora lists.
- Increase in the area of habitat managed for the control of weeds and phosphite control of *Phytophthora.*

Tasks / Activities – Relevant Science Project Plans:

SPP No.	**Project Title**	**Key Activities**	**Milestones** (*Targets to be achieved over quarterly time frame)*	**Outputs** *(Reports, publications, seminars, field days* etc)
93/0043	*Seed biology, seedbank dynamics and the long term germ plasm storage of WA flora especially rare, threatened and commercially utilised flora*	1. Field seed collections 2. Seed viability testing 3. Input of all data into WASeed database 4. Soil seed bank and seed viability studies	3/01 50-60 seed collections accessed into TFSC for duplication at RBG Kew 6/01 Viability testing completed on 50% of collections. 9/01 Viability testing completed for 2000/2002 field collections 12/01 Commencement of field collections of seed from new priority species 3/02 Complete field collections for 2001/2002. 3/06 Viability testing completed on 50% of collections.	1. Yearly and half yearly progress reports to NHT 2. Yearly and half yearly progress reports to RBG Kew 3. Rare Flora report forms forwarded to Wildlife Conservation Section 4. Article for *Landscope* on Millennium Seed Bank Project collaboration
93/0044	A quadrat based monitoring system for	Quadrat based monitoring sites on threatened flora	6/01 Finalise monitoring report and recommendations with WATSCU	Protocols for monitoring ecological processes in populations of threatened flora

	endangered flora		12/01 Provide Districts with feedback on monitoring sites set up under CP "The population ecology of critically endangered flora"	
93/0045	Population based surveys, conservation status and area based wildlife management programs for rare and threatened flora	1. Create field work schedules for flowering seasons 2001 and 2002 2. Commence field investigation in liaison with regional staff 3. Commence write up of species account for 170 rare and priority taxa listed for the Goldfields region	3/01.Complete fieldwork schedules for 50 taxa Species accounts prepared for 20 taxa 6/01 Species accounts prepared for 30 taxa 9/01 Undertake at least one field trip with Goldfields Regional staff 12/01 Species accounts prepared for 20 taxa Complete rare flora report forms. Incorporate voucher specimens to WA Herbarium 3/02. Complete fieldwork schedules for 50 taxa. Write species accounts for 30 taxa 6/02 Write species accounts for 30 taxa	1. Rare Flora report forms forwarded to Wildlife Conservation Section 2. Completed species accounts forwarded to Region for additional information 4. Recommendations to Wildlife Branch and Threatened Species Scientific Committee regarding changes in conservation status of target taxa where appropriate
93/0068	93/0068 Integrating strategies for the control of *Phytophthora cinnamomi* with phosphite	Determine longevity of action of phosphite in plants	3/01 Challenge inoculate & assess lesion development. 6/01 organise Honours project at Murdoch Uni 9/01 Challenge inoculate & assess lesion development 12/01 submit annual report to NHT Setup and spray plots 3/02 Challenge inoculate & assess lesion development 6/02 review data for publication	Annual report to NHT
96/0012	Susceptibility of major soil types of the FRNP to infestation by *P. megasperma* and *P. cinnamomi*	Determine susceptibility of major soil types in FRNP to *P. cinnamomi*	6/01Commence analysis of results 12/01 Write up results	Report/publication on susceptibility of soil types
96/0009	Resurvey and analysis of Podger's dieback sites after 30 years.	1. Complete checking data 2. Undertake analysis of Karnet and Scarp blocks	3/01Complete checking of data 6/01 Complete initial analysis of data	Graphical summary of major trends on *Phytophthora cinnamomi* impact.
98/0001	*Selection for resistance to* Phytophthora cinnamomi *in* Banksia coccinea	**1. Monitor survival and growth and test dead plants for P.c infield trial at Mt Cooke**	**June 2001**	
98/0003	Genetics and biosystematics for the conservation, circumscription and	1. Investigate possible hybrid origins of *Eucalyptus bennettiae* 2. Investigate genetic relationships between populations of *Synaphea stenoloba*	3/01 Sample populations of *E. bennettiae* and putative parents. 6/01 Sample populations of *S. stenoloba.* 9/01 Complete analysis of E. bennettiae.	1. Report and journal paper on hybrid status of *E. bennettiae.* 2. Report and journal paper on genetic relationships in *S. stenoloba.* 3. Report on genetic

	management of Western Australian flora	3. .Investigate genetic differentiation in *Dryandra ionthocarpa*	12/01 Complete analysis of *S. stenoloba* 3/02 Submit journal paper on hybrid origins of *E. bennettiae* 6/02 Complete analysis of *D. ionthocarpa*	differentiation in *D. ionthocarpa*
98/0017	*Acacia acuAcacia ccuminata* analysis of variation.	Investigate taxon boundaries and phylogeographic patterns in the *Acacia acuminata* complex	3/01 Finalise publications on Patterns of allozyme variation and cp DNA variation	Two publications in international journals Allozyme variation in the A. *acuminata* complex Phylogeographic patterns and cpDNA variation in the *A. acuminata* complex
99/0005	WATTLE, a computer-based information system for the genus *Acacia*	1. Assemble WATTLE information for publication in 2001. 2. Prepare seminars & workshops on use and functionality of the WATTLE information & identification system. 3. Prepare funding applications for WATTLE Phase 2. 4. Commence construction of WATTLE Phase 2 database.	3/01: Finalize publication of WATTLE (Phase 1) . 6/01: Attempt to secure funding for WATTLE Phase 2. 9/01: Commence construction of WATTLE Phase 2 (subject to funding)	1. Publication of the WATTLE CD. 2. Present Seminars/Workshops on use and functionality of the WATTLE identification and information system
99/0010	Seed biology, dynamics and long term germ plasm storage.		1/01 Establish links with Kew Gardens Millennium Seedbank project	
99/0019	Susceptibility of rare and endangered flora to *Phytophthora cinnamomi*	1. Record mortality following pot inoculation of rare and threatened flora	3/01 Inoculate plants and assess mortality 3/02 Inoculate next batch of plants and assess mortality 6/02 - review data for publication	1. Database of ranking threatened flora susceptibility to *P. cinnamomi* 2. Present results at the IUFRO conference Nov 2001
99/0020	Rare and poorly known flora thought to be Endangered or Critically Endangered	1. Draw up final list of Priority Flora to be targeted for survey 2.Carry out field work, finishing work on those taxa commenced 1999 3.Write up reports, complete report forms and incorporate voucher specimens 4. Make recommendations for upgrade or downgrade in conservation listings of target taxa	3/01 Complete list and schedule of target taxa for 2001 6/01Complete winter fieldwork 9/01Complete spring fieldwork Final report to NHT 12/01Complete Report forms, incorporate voucher specimens and make recommendations in relation to taxa completed 2001 3/02Completed list and schedule of target taxa for 2002 6/02Complete winter field work, writeup report and forms, incorporate voucher specimens	1. Annual and interim reports to NHT 2. Report forms to Wildlife Conservation Section 3. Recommendations for addition of taxa to State and ANZEC threatened flora lists with their IUCN ranking 4. Recommendation of taxa to lower priority for conservation action 5. Voucher specimens incorporated into WA herbarium
2000/0012	Wattles in the Dalwallinu Shire.	1. Organize and conduct Acacia Symposium ("The conservation and utilisation potential of Australian dryland acacias") & associated tour (to WA wheatbelt	3/01: Acacia tour & Symposium organized. 6/01: Legume Conference & Acacia Symposium papers prepared. 9/01: "Legumes Down Under" Conference	1. Symposium on utilisation potential of Acacia presented. 2. Proceedings of Acacia Symposium edited & published. 3. Journal papers on Acacia

		& adjacent rangeland). 2. Editorial work on Proceedings of Acacia Symposium	(Canberra) and Acacia Symposium (Dalwallinu) attended & papers presented; Acacia tour conducted. 12/01: Acacia Symposium proceedings edited; journal papers prepared for publication. 3/02: Acacia Symposium proceedings published. 3/02: Book "Wattles of the Dalwallinu Shire" commenced	published. 4. Book: 'Wattles of the Dalwallinu Shire" commenced
2000/15	The population ecology of critically endangered flora	1. Assessing the limitations on population growth in the critically endangered *Acacia cochlocarpa ssp. cochlocarpa* and *A. aprica* 2. The reproductive and ecological attributes of the rare *Acacia lobulata* and *A. sciophanes* and their common relatives *A. verricula* and *A. anfractuosa* 3. Genetic relationships and population biology of *Acacia* sp. Dandaragan 4. Pollinator abundance, pollination rates and seed production in relation to population size and landscape context in the rare *Verticordia fimbrilepeis ssp. fimbrilepis* 5. Life history and population dynamics of the rare *V. fimbrilepis ssp. fimbrilepis, V. staminosa spp. staminosa* and *Calytrix breviseta ssp. breviseta* 6. Assessing the limitations on population growth in critically endangered flora in the Moora District 7. Post fire recovery of the critically endangered East Stirling's Montane Vegetation community and its critically endangered taxa	03/01 Complete report and journal paper on *Acacia* sp. Dandaragan 03/01 Begin field surveys and experiments in Moora District criticals 6/01 set up monitoring sites on East Stirling's montane community 12/01. Complete analyse of *V.staminosa staminosa* data 03/02 Complete data analysis of *Acacia lobulata* and *A. sciophanes* and their common relatives *A. verricula* and *A. anfractuosa* Complete data analysis of *Acacia cochlocarpa ssp. cochlocarpa* and *A. aprica* 06/02 Complete report and journal paper on *Acacia cochlocarpa ssp. cochlocarpa* and *A. aprica* Complete report and journal paper on *Acacia lobulata* and *A. sciophanes* and their common relatives *A. verricula* and *A. anfractuosa* Complete data analysis and report and journal paper on *Verticordia fimbrilepeis ssp. fimbrilepis*	1. Reports and journal papers 2. Recommended recovery actions and management prescriptions in Threatened Flora Recovery Plans
CP	Control and management of weeds on populations of threatened flora and in	1. Assessment of weed impacts 2. Experimental assessment of weed control strategies in conjunction with habitat	6/01 Selection of appropriate sites on threatened flora populations and/or in Threatened Ecological communities for monitoring and experimental weed	1. Reports on the impact and control of weeds 2. Recommended recovery actions in Threatened Flora Recovery Plans and Threatened Ecological

	threatened ecological communities	restoration	control 3/02 Complete investigations of the impacts of weeds on the establishment and growth of Acacia aprica and *Verticordia fimbrilepeis ssp. fimbrilepis* seedlings and 6/02 commence weed control experiments on selected sites	Community Recovery Plans
2001/01	Mating system variation, genetic diversity, and viability of small fragmented populations of threatened flora and other key plants of conservation importance.	1 Mating system analysis and viability of small populations 2.Genetic variation in small fragmented populations	3/01 Finalise seed collections for *Banksia cuneate* and *B. oligantha* 6/01 Complete allozyme and mating data analysis of *Banksia cuneata* and *B. oligantha* Complete mating system analysis of *Verticordia fimbrilepeis ssp. fimbrilepis* Prepare genetic variation paper on *Banksia cuneata* and *B. oligantha* 9/01 Complete data analysis on mating systems in critically endangered Verticordias and Acacias 12/01 Prepare mating system paper on *B. cuneata* Prepare genetic variation paper on *Verticordia fimbrilepeis ssp. fimbrilepis* 03/02 Prepare mating system paper on *Verticordia fimbrilepeis ssp. fimbrilepis* 6/02 Prepare mating system paper on critically endangered Verticordias and Acacias	1. Reports and Journal papers on mating systems and genetic variation in *Banksia cuneata*, *Banksia oligantha*, and critically endangered Verticordias and Acacias 2. Recommended recovery actions and management prescriptions in Threatened Flora Recovery Plans
CP	Experimental translocation of critically endangered plants	Experimental translocations of critically endangered plants	3/01 complete assessment of suitable sites for the translocation of six critically endangered flora 6/01 Complete experimental translocations of 3 criticals 9/01 Complete experimental translocations of another 4 criticals Complete translocation database 12/01 Complete annual monitoring of 9 translocations from 1998 3/02 prepare paper on experimental translocations of nine critically endangered flora	1. Reports and Journal papers on experimental translocations of nine critically endangered plants 2. Protocols for translocations and for assessing translocation success
TBA	To evaluate the extent to which *P. megasperma* and other biotypes of Phytophthora pose a threat to higher plant	Assessment of threat of various *Phytophthora* taxa other than *P. cinnamomi*	03/01 Completion of report	Final consultancy report

	communities of the Weld catchment and region, FRNP and region, and northern sandplain			

Anticipated Outcomes:

- Reductions in the number of plant taxa and ecological communities on threatened lists through the development of scientifically based management prescriptions and recovery actions in Threatened Flora Recovery Plans and Threatened Ecological Community Recovery Plans
- Genetically representative *ex situ* germplasm storage covering all threatened flora (DRF) and other high priority flora particularly those targeted in the Salinity Action Plan and as part of the Millennium Seed Bank Project
- Increased recovery of threatened flora, particularly critically endangered flora, by translocations through the development of appropriate translocation methodologies and protocols for assessing translocation success
- Up to date lists and the improved ranking of threatened and Priority flora by strategic survey, assessment of conservation status and collaboration with operational staff and District Flora Recovery teams.
- Amelioration and control of the major threatening processes, invasive weeds and *Phytophthora* root rot, in populations of threatened flora, threatened ecological communities and in areas of high conservation value

Adoption Strategy:

- Research outcomes will be delivered as part of Western Everlasting initiatives and through continued liaison with Nature Conservation Division, District, and Regional staff, and Threatened Flora Recovery Teams.

More specific adoption strategies include:

- The incorporation of recovery actions into approved Threatened Flora Recovery programs, District/Regional based flora management programs, Threatened Ecological Community Recovery Programs
- The incorporation of actions relating to genetically representative *ex situ* germ plasm storage, from threatened flora (DRF) and other high priority flora, into approved Translocation Programs, Threatened Flora Recovery Programs, Threatened Ecological Community Recovery Programs, the Salinity Action Plan and Millennium Seed Bank Access and Benefit Sharing Agreement
- Up to date lists and the improved ranking of threatened and Priority flora through recommendations to the Threatened Species Scientific Committee, Nature Conservation Division, and District and Regional staff.
- The incorporation of actions relating to the amelioration and control of the major threatening processes, weeds and *Phytophthora,* in approved Threatened Flora Recovery Programs and Threatened Ecological Community Recovery Programs and operational manuals for District and Regional staff
- Publication of research findings as reports or in journals within twelve months of final data collection

Partnerships / Collaborators:

Staff in this program have developed effective collaborations with a range of external institutions. These collaborations include supervision of Honours and post graduate students, joint field trips, and formal agreements to share intellectual property. Relevant institutions include:

- Botanic Gardens and Parks Authority
- University of Western Australia
- Murdoch University
- Curtin University
- CSIRO
- Royal Botanic Gardens Kew, UK

Staff:

Staff	**Location**	**FTE**
M. Byrne	Herbarium	0.5
D. Coates	Herbarium	1.0
A. Cochrane	Herbarium	1.0
B. Maslin	Herbarium	0.8
S. Patrick	Herbarium	1.0
B. Shearer	Como	1.0
C. Yates	Herbarium	1.0
L. Monks	Herbarium	1.0
P. Gioia	Herbarium	0.1
Scientist total		**7.4**
H. Coleman	*Herbarium*	*0.8*
C. Crane	*Como*	*1.0*
R. Fairman	*Herbarium*	*1.0*
V. Hamley	*Herbarium*	*0.7*
B. McDonald	*Herbarium*	*0.5*
Tech Officer total		**4.0**
Program TOTAL		**11.4**

Budget (Annual):

Salaries	$635 000
Overheads	$111 000
Operating: external*	$249 000
Operating: CF #	$30 000
TOTAL	**$1 025 000**

* Based on annual expenditure for 1999 – 2000
# Based on CF allocation for 2000 - 2001

Program 3: Disturbance Ecology and Management

Program Leader: Mr Angas Hopkins

Output Purchaser: Nature Conservation

Key Result Area:
Provision of sound advice on management of the State's biota (both on and off reserves) based on an understanding of ecological processes at the population, community, ecosystem and landscape levels.

Description:
This program contributes to the Nature Conservation Output objective of achieving an *understanding of our State's natural biodiversity and biodiversity conservation needs.*

The program aims to develop the knowledge base underpinning scientific management of the biota of the State. The focus is on the study of change in populations, communities, ecosystems and landscapes over time, including those changes resulting from disturbance in the context of overall environmental patterns. The studies cover both terrestrial and aquatic ecosystems, and the disturbances include fire, grazing, mining and related clearing, flooding, and changes to water quality. Through activities associated with CALM's membership of the Co-operative Research Centre for Sustainable Development of Tropical Savannahs, a range of disturbance factors affecting riparian communities in the Kimberley are being addressed. The array of fire-related SPPs involve studies in most CALM Regions (Kimberley, Pilbara, Goldfields, South Coast, Mid West, Wheatbelt, Central Forest, Southern Forest) and biomes (tropical savannah, spinifex deserts, arid and semi-arid woodlands, kwongan, mesic shrublands and south west forests). The SPPs include site-specific case studies as well as generic studies. Current issues include application of fire as a management tool as well as the interaction of various fire regimes with vegetation,

floristics, vertebrates and invertebrates.

Objectives:
Understand the processes that sustain the populations, communities, ecosystems and landscapes of the State, including the effects of disturbances on these entities; and
Develop guidelines for the management of the populations, communities, ecosystems and landscapes based on this understanding.

Significance and Benefits:
A critical element of CALM's role in conserving the biological diversity of the State is its ability to manage its estate, to advise on management of off-reserve conservation areas, and to contribute to the management of flora and fauna populations generally. This project will develop the scientific understanding of natural and human-induced processes and the responses of populations and communities provide practical management guidelines and, ultimately, contribute to the overall improvement in the quality of management decisions and practices.

Results Expected:
Identification of best practice in management of the conservation estate and off-reserve areas including minimising deleterious disturbances and restoration;
An understanding of the impacts of different fire regimes on biodiversity,
A knowledge of rehabilitation after disturbance, including mining and gravel extraction;
A sound knowledge of the application of disturbance ecology principles at the landscape scale.

Tasks / Activities – Relevant Science Project Plans:

SPP No.	**Project Title**	**Key Activities**	**Milestones** ***(Targets to be achieved over quarterly time frame)***	**Outputs** *(Reports, publications, seminars, field days* etc)
93/0062	Management of the Busselton wetlands : control of water levels and other perturbations and their impacts upon breeding of the Black Swan (Cygnus atratus)JLane0 % Gpearson0%)	Project suspended	Project suspended	Project suspended
93/0160	Using prescribed fire to rehabilitate landscapes disturbed by mining exploration in the arid zone. (N. Burrows 1% B Ward 5% G Liddelow 5%)	Prepare manuscript On-going monitoring of sites at Rudall River national Park and Telfer minesite	July 2001: Annual field assessment December 2001: Submit ms for publication - Journal of Arid Environments	Scientific Publication, Hummock Grassland Fire Behaviour Guidelines
93/0090	Effect of fire on plant communities at Tutanning Nature Reserve. (A Hopkins 20%, M Langley 30%)	Finalise field sampling, collate data, analyse data and produce scientific and popular papers on the results. Provide advice to relevant managers.	June 2002 - Complete data entry Dec 2001 - Analyse data Dec 2001 - Produce the first two papers on the results of the studies Dec 2002 - Complete write-up of scientific papers Dec 2002 - Provide advice to Wheatbelt Region management staff on results of the studies at Tutanning.	Two scientific papers submitted (February 2002) Further two scientific papers submitted (February 2003) Advice to Wheatbelt Region management staff
93/0141	Fire-mulga	Undertake 10 year project	Jan 2001- Complete review	Scientific and technical

	study: burn and post-fire monitoring (S. Van Leeuwen 20%, A.N.Start 10%, B.Bromilow 20%, P.Fuller 10%)	review Prepare schedule of publications Applied for external funding Complete flora & vertebrate fauna identifications Commence invertebrate sorting Undertake review	Dec 2001 - Complete flora ids Resample 70 km of transect Dec 2001 - Prepare first draft paper on the results of the transect study June 2002 - Provide advice to Pilbara Region and CALM's EP Branch on fire management of Central Pilbara mulga woodlands. June 2001 - Provide advice to DEP/EPA, DRD and DOME together with industry on conservation significance of Central Pilbara mulga woodlands	papers Advice to other CALM Divisions. Advice to external government and non-government agencies. Critical review of proposed developments and their EIS
93/0085	Post-fire response of mallee heath shrubland at Stirling Range NP (L. McCaw)	Undertake field assessment of floristics and structure 10 years post fire. Analyse data and prepare manuscripts	9/01 Contribute data for paper to fire seminar. 10/01 Field assessment 3/02 Manuscripts ready for internal review	Two scientific papers: fuel accumulation, changes in floristics in response to fire Contribution to chapter on vegetation response for book on Fire in south-west ecosystems.
93/0086	Fire-induced mosaics in semi-arid shrubland & woodland communities (L McCaw)	Analyse data and prepare manuscript.	12/01 Manuscript ready for internal review.	Technical paper on fire mosaics and links with regeneration of Callitris
93/0092	Fire effects on desert vertebrates: influence of fire season (D. Pearson 20%)	Long term monitoring of the impacts on vertebrate fauna of fires in summer and spring in hummock grassland in the Great Victoria Desert. Documenting changes to terrestrial invertebrate populations (as potential prey for vertebrates) and vegetation cover in these different fire types. Collection of data on threatened or restricted species which occur in the study area, particularly the Sandhill Dunnart, *Sminthopsis psammophila*. Feedback to regional staff and publications on appropriate fire regimes to maintain biodiversity and protect populations of threatened species.	Dec 2001 - No work planned. Sort of invertebrate samples up to 1994. June 2001 - Entry of recent vertebrate trapping data and preliminary statistical analyses. Dec 2001 - Preparation of manuscript on short-term impacts on reptile guilds. Mar 2002 - Trapping/monitoring of study area March 2002. Jan 2002 -Completion of manuscript on fire impacts on reptiles.	Manuscript on the impact of fire on hummock grassland reptiles. Workshop with CALM Goldfields Region staff on managing fire for conservation in desert lands.
93/0075	Effects of spring and autumn prescribed burning on small vertebrates in Jarrah forest (Batalling) (A. Wayne)	Database development and validation Data analysis	4/01 Data to be validated and analysed by for presentation to workshop contributing to revision of the Forest Management Plan. 9/01 Presentation to Fire Seminar	Annual seminar and training session for the Fauna Management Course for operations staff held in November. Chapter for book on Fire in South-west Australian Ecosystems
93/0026	Rainforest management and monitoring (N McKenzie	Identify, compile and analyse Nimbing limestone reef quadrat data with Kimberley	6/01 - compile Nimbing manuscript 5/01 - sample Oscar Napier quadrats	Quantitative data on limestone biodiversity patterns, and rainforest mgmt issues, including.

	10%)	rainforest matrix Collect bird and dry season plant Oscar Napier limestone reef quadrat data Regional ecologist to re-survey rainforest monitoring transects	3/02 – include transect data in report	reserve needs in Devonian reefs. 8 years of fence-fire-rainforest condition data relevant to management. Management advice
93/0060	Monitoring wetlands in Western Australia's conservation reserves J. Lane	Continue monitoring water & maintenance of gauges at 90+ wetlands Provide results to clients	Sept & Nov 2001 - monitor & maintenance Dec 2001 - data entered & validated On-going – advice to clients	Database on wetlands throughout the south west of WA Advice to clients
93/0091	*Development of a Departmental monitoring program (A Hopkins 5%)*	Maintain information base for Departmental use Provide advice to CALM Regional staff and other relevant organisations	on-going – advice to Regional staff 1/01 - workshop on biodiversity monitoring in rangelands 10/01 – pilot project in Gascoyne-Murchison area 06/02 – report on rangelands monitoring pilot project	Advice to Regional staff Report on biodiversity monitoring in Western Australia's rangelands
95/0006 (incorporating 98/0004, 98/0022, 99/0007)	*Monitoring river health initiative – Western Australia (S. Halse 30%, M. Scanlon 100%, J. Cocking 100%)*	Refine model for assessing river condition using aquatic macroinvertebrates Improve invertebrate sampling methods for assessing river condition Collate assessments of ca 650 sites throughout WA	AusRivAS sampling manuals on national website (Jan 2001) Models for assessing river condition in WA on national website (March 2001) Assessment of river condition at 650 particular sites in WA and summary of overall river condition in WA (March 2001)	Final report to Environment Australia, to be submitted March 2001 Paper on effect of different invertebrate sampling methods on assessment of river condition to be submitted June 2001
98/0004	First national assessment of river health – North-west Australia See 95/0006	Refine model for assessing river condition using aquatic macroinvertebrates Improve invertebrate sampling methods for assessing river condition Collate assessments of ca 650 sites throughout WA	Mar 2001 - Models for assessing river condition in WA on National Website. Mar 2001 - Assessment of river condition at 650 particular sites in WA and summary of overall river	Final report to Environment Australia, to be submitted March 2001 Paper on effect of different invertebrate sampling methods on assessment of river condition to be submitted June 2001
98/0022	First national assessment of river health – Wheatbelt Region See 95/0006	Refine model for assessing river condition using aquatic macroinvertebrates Improve invertebrate sampling methods for assessing river condition Collate assessments of ca 650 sites throughout WA	Mar 2001 - Models for assessing river condition in WA on National Website. Mar 2001 - Assessment of river condition at 650 particular sites in WA and summary of overall river condition in WA.	Final report to Environment Australia, to be submitted March 2001 Paper on effect of different invertebrate sampling methods on assessment of river condition to be submitted June 2001
99/0007	First national assessment of river health – South-West Forests See 95/0006	Refine model for assessing river condition using aquatic macroinvertebrates Improve invertebrate sampling methods for assessing river condition Collate assessments of ca 650 sites throughout WA	Mar 2001 - Models for assessing river condition in WA on National Website. Mar 2001 - Assessment of river condition at 650 particular sites in WA and summary of overall river	Final report to Environment Australia, to be submitted March 2001 Paper on effect of different invertebrate sampling methods on assessment of river condition to be submitted June 2001
98/0018	Salinity Action Plan - Monitoring salinity and its effects on the	Monitoring biophysical condition of a sub-set of wetlands (25 for flora & fauna, 100 for physico-chemical attributes).	3/01 -- review first 3 yrs monitoring 7/01 -- third report received from ECU 6/02 -- scheduled monitoring	Tender process completed successfully Consultant's report lodged Consultants report approved

	biota of wetlands in the agricultural zone of south-western Australia. (GJ Keighery, N.Gibson, S.Halse, J.Lane)	Refer to State Salinity Strategy for detail.	of sites for 2001-2 completed	
99/0012	Monitoring of Carnac and Penguin Island Silver Gull Populations (J.Lane 3%, A.Clarke 1%)	Conduct May 2001, May 2002 photo censuses of Carnac I. and Penguin I. gull populations. Count gulls from aerial photographs of 2000, 2001. Analyse trends in gull populations	5/01 Complete 2001 census. 9/01 Complete counts from aerial photos of 2000, 2001 censuses. 10/01 Complete trends analysis of data to 2001. 5/02 Complete 2002 census	Report on results of gull censuses to May 2001 (Nov 2001).
99/0016	Monitoring of impacts of Dawesville Channel on waterbird Usage (J.Lane 15%, G.Pearson 5%, A.Clarke 10%)	Conduct Feb 2001 count of Peel-Harvey pelican and swan populations. Conduct Oct 2001, Dec 2001 and Feb 2002 counts. Analyse data and prepare report on results of 1996/97 & 1998/99 Peel-Harvey waterbird surveys	2/01 - Complete 2000/01 pelican and swan counts. 6/02 - Complete analysis and reporting of pelican and swan data. 3/02 - Complete analysis and reporting of waterbird survey data	Report on results of pelican and swan counts to Feb 2002 (Jun 2002). Report on results of waterbird surveys (Jun 2002).
RPP 53/91	Effects of fire on plant species and communities at Stirling Range National Park (A Hopkins 5%, M Langley 5%)	Finalise field sampling, collate data, analyse data and produce scientific and popular papers on the results. Provide advice to relevant managers.	Collate existing data and undertake a preliminary review of results (December 2001) Advise on the continuation of this project.(February 2002)	Scientific and technical publication Advice to Regional staff
2000/01	Integrated overview of values, uses and modifying processes in the Ord River's riparian zone. (A.N. Start 75%, T.Handasyde 100%)	Review and data compilation, identification of priority research needs	Dec 2001 - Complete data collection on biological aspects Dec 2001. Dec 2001 - Complete hydrological/ geomorphological work. June 2001 - Complete progress reports to Tropical Savanna CRC.	Progress reports Database on the region's biophysical factors Scientific and technical publications Advice to CALM Regional staff and other managers in the region, including community groups
2000/04	Demography of Australian Boab (*Adansonia gregorii)* stands in relation to grazing and fire.N.Burrows 1% A.N. Start 5%)	Monitoring of fire response plots Analysis of data Preparation of scientific reports	5/2001 - Prepare progress report.	Progress reports Scientific and technical publications Advice to CALM Regional staff and other managers in the region, including community groups
2000/08	Mistletoes and their fire ecology in Western Australia (A.N.Start 5%)	Collection of data on mistletoe distribution, host relationships and the influence of fire in Western Australia. Data is gathered opportunistically during field activities pertaining to other projects	Dec 2001 - On-going: data collection and maintenance of a database (in personal time), re-determine WA Herbarium's mistletoe collections, complete identifications	Scientific publications: Mistletoe – fire ecology paper for Pilbara., Mistletoe – fire relationships in Kimberley Descriptions of new taxa. Advice to scientific community and CALM Regional staff
99/0017	Assessment of impacts of management actions on nature	Consultant finalise report on establishment of fringing vegetation monitoring program. Install shallow	Feb 2001 - Receipt of completed report on vegetation monitoring. May 2001 - Installation of monitoring bores	Report on establishment of vegetation monitoring program (Feb 2001). Report on installation of monitoring bores (Jul

	conservation values of the Vasse-Wonnerup wetlands (J. Lane 5%, G. Pearson 3%, Y.Winchcombe 2%, A. Clarke 1%).	groundwater monitoring bores. Monitor water levels of the estuaries. Analyse data and prepare report on waterbird counts of 1998-2000. Analyse data and prepare report on salinity profiling of 1998-2000.	completed. Mar 2001 - Complete downloading, conversion, calibration and graphing of 2000 water level data. Mar 2002 - Complete downloading, conversion, calibration and graphing of 2001 water level data. Mar 2002 - Complete analysis and reporting of salinity profiling data. Jun 2002 - Complete analysis and reporting of waterbird count data	2001) Annual graphs of water level variations of the estuaries (Mar 2001, Mar 2002). Report on results of salinity profiling (Mar 2002) Report on results of waterbird counts (Jun 2002).
No SPP	National Reserve System Working Group and development of IBRA (N. McKenzie 5%) Environmental Health (N. McKenzie & A. Hopkins 5%)	Further development of IBRA sub-regionalisation in WA Environmental health attributes for WA sub-regions	5/01 -- Environment Australia's release of Sub-region diagnoses and interim map. Dec 2001 - production of 2 sub-regional biodiversity plans in WA (western Avon & North Kimberley).	WEB-published map and notes. Two WA sub-regional environmental health mgmt plans sent to EA-NHT Theme 7, part of a national strategy for taking requirements from sub-regional to national scale

Anticipated Outcomes:
The projects within this program will produce guidelines for management of the CALM-estate and off-reserve conservation areas. The focus of the initial guidelines will be in the areas of fire management and wetland management.

Adoption Strategy:
Liaise with CALM's Regional Services staff, land-holders including those with off-reserve conservation areas, officers of the Department of Environmental Protection, and other branches of CALM, on conservation management problems. Continue to promote findings of the studies under this program through publications, seminars, meetings, committee membership, advice to the Nature Conservation Division etc.
Examples include the forthcoming book on Fire in the South West of Western Australia, and contributions to the on-going review of fire management within CALM's Nature Conservation Division.

Partnerships/Collaborators:
In delivering of services, this program will enter into collaborative arrangements with the following organisations:

- Agriculture Western Australia
- Botanic Gardens and Parks Authority
- University of Western Australia, Murdoch University, Curtin University, Edith Cowan University
- CSIRO
- TSM-CRC

Staff:

Staff	**Location**	**FTE**
N. Burrows	Kensington	0.02
A. Hopkins	Woodvale	0.50
L. McCaw	Manjimup	0.05
D. Pearson	Woodvale	0.20
S Halse	Woodvale	0.30
T. Start	Kununurra	0.95
S. van Leeuwen	Karratha	0.20
A Wayne	Manjimup	0.05
N McKenzie	Woodvale	0.10
N Gibson	Woodvale	0.02
B. Bromilow	Karratha	0.20
P. Fuller	Woodvale	0.60
**T. Handasyde*	Kununurra	1.00
**J. Harvey*	Woodvale	0.50
B. Johnson	Woodvale	0.10
M Langley	Woodvale	0.30
C. Ward	Manjimup	0.10
B Ward	Manjimup	0.05
G Liddelow	Manjimup	0.05
**M Scanlon*	Woodvale	1.00
**J Cocking*	Woodvale	1.00
Total		**6.99**

*T Handasyde, M Scanlon, J Cocking are 100% externally funded. J Harvey has resigned, and is presently acquitting her accumulated leave - he 0.50 is notional only, for book keeping purposes.

Budget:

Salaries	
Overheads	
Operating: External	
Operating: CF	
TOTAL	

Program 4: Biological Survey & Reserve System

Output Purchaser: Nature Conservation

Program Leader: Mr Norm McKenzie

Key Result Areas:
1. Terrestrial and Marine conservation reserve system
2. Off-reserve biodiversity conservation and sustainable use

Program Description and Objectives:

Description:

This program contributes to the Nature Conservation output objective of achieving an understanding of our State's natural biodiversity and biodiversity conservation needs. The program's core activity is a systematic, point-based, broad-scale, zoological and botanical survey of the bioregions of WA. An array of smaller projects are undertaken in parallel with the regional surveys: surveys of localised areas, communities and taxa of particular conservation interest (on and off-reserve), investigations of biological survey strategies, sampling methods and data analysis.

Objectives:

The program provides quantitative data on patterns in the species composition of indigenous plant and

animal communities across the bioregions of WA. In particular, the program aims to: (1) Identify gaps in the coverage of the State's existing conservation reserve network and identify specific areas of land that most efficiently lead to a comprehensive, adequate and representative reserve system in WA. (2) Advise on species and community conservation status, and the species composition and definition of ecological communities (in geographical and environmental domains) for land-use planning. (3) Maintain / contribute to the contemporary understanding of the factors affecting persistence of indigenous communities and species. (4) Review, develop and incorporate in surveys, cost-effective methods and strategies of sampling a wide array of taxa, and of analysing ecological survey data. (5) Describe a set of benchmark quadrats that provide a basis for long-term ecological monitoring of WA's biodiversity.

Significance and Benefits:
The data on biodiversity patterns, ecological relationships, and conservation status provided by this program are the scientific basis for many conservation decisions made by CALM. For instance, these data are required for planning a reserve system that is optimised to sample and retain WA's biodiversity. The point-based sampling program allows the results of different surveys to be combined with the objective of gradually accumulating coverage of the whole State, and yields a stratified network of long term monitoring sites across WA's bioregions, for measuring trends in species and community status. The ongoing development of survey strategies, sampling methods and data analysis ensures that the surveys remain cost-effective, and their publication in refereed journals ensures that they are scientifically rigorous.

Targets / Results Expected:

- Data matrices will be compiled and archived on species composition and physical attributes at a representative set of sites throughout the Goldfields, southern Carnarvon Basin, Wheatbelt, Burrup Peninsula, Nimbing Ranges, Oscar-Napier Ranges, Woodlands of Swan Coastal Plain, West Midlands, coastal communities in the Warren Region, Cape Arid NP, Yanchep NP, Karijini NP uplands, Barley Range NR, Goldfields woodlands, Pilbara tussock grasslands, western Little Sandy Desert, Byenup-Muir wetlands, inter-tidal mudflat community of 80-Mile Beach and Darling Scarp.
- Reports, papers or books with management or land-use recommendations/implications will be drafted, submitted or published on southern Carnarvon Basin biodiversity, Wheatbelt biodiversity-salinity, Coolgardie bat fauna, Cape Arid NP biota, Yanchep NP biota, flora of Karijini NP, Burrup Peninsula flora, Barlee Range biota, Little Sandy Desert biodiversity and Two Peoples Bay NR biodiversity.
- Reports/papers dealing with aspects of the WA biota, species conservation status, community status, or survey methodology will be submitted or published on community analysis (nested species sub-assemblages), new WA Copepods, distributions of WA Ostracods, cross-taxon congruence, taxonomy and environmental tolerances of Australian oligochaetes, Lyssavirus and other pathogens carried by WA bats, Karijini management taskforce, Long-eared Bat echolocation signatures, Directory Of Important Wetlands in Australia 3rd Edition, substrate-type and invertebrate biomass of 80-Mile Beach mudflats, bat foraging strategies.

Tasks / Activities next 18 months – Relevant Science Project Plans:

SPP No.	Project Title	Key Activities	Milestones	Outputs
91/0057	Survey software and analysis N McK, NG & JR	Continue to develop analytical tools	Mar 2002 - Automate GLIM modelling and nested sub-set test. May 2002 - PATN analysis of species-assemblage domains	More rapid exploration of survey data-sets.
93/0025	Eastern Goldfields survey N McKenzie	finalise goldfields vertebrate data-basing compile Goongarrie trapping data	6/02 - Archive vertebrate matrix, including Goongarrie data	Provide data matrix to Goldfields region.
93/0027	Buccaneer Archipelago survey N McKenzie	defer write-up until time is made available.	June 2002 - Archive vertebrate matrix, including Goongarrie data	Liaise with region, providing advice and data for land-use plans
93/0028	Ecomorphological clues to community structure: Bat and lizard	Publish paper on foraging strategy/ resource partitioning of Coolgardie Bats Prepare paper on flight	June 2001 - paper on foraging strategy of Coolgardie bats published Mar 2001 - *Nyctophilus* fieldwork and analysis	Liaise with forest ecologists on factors determining composition of bat communities in relation to vegetation structure (e.g.

	guild studies, bat echolocation studies N McKenzie	speed/power of Coolgardie bats. Record 5 additional calls for each south-western species, then finalise draft paper on distinguishing WA *Nyctophilus* from their echolocation calls Prepare MS on structure of Little Sandy Desert bat fauna; environmental productivity as a factor determining faunal composition. Re-sample Lyssavirus (bat rabies) in northern WA and sample southern regions	completed Dec 2001 - papers on bat flight speed/power and *Nyctophilus* identification submitted for publication. Apr 2001 - Kimberley and Pilbara Lyssavirus sampling extended, and first sampling in south-west completed. 8/01 - paper on pathogens carried by bats in NW Australia drafted	likely affects of different timber-extraction practices on bat communities). Train forest monitoring staff on surveying bat assemblages using echolocation call signatures. Recommend on warning signs / inoculations in relation to bat rabies (CALM has duty-of-care to staff and park visitors at Millstream etc).
93/0030	Biological survey of the Barlee Range Nature Reserve SvL	write various papers edit and finalise report to funding agency Finalise budget expenditure and recoups	Feb 2001 - report completed and submitted to funding agency Apr 2001 - draft report submitted to CALMscience for review June 2001 - final report re-submitted for publication in CALMscience	recommendations to region on interim management guidelines Report to funding agency Publications in CALMscience
93/0031	Botanical survey of the Hammersley Range uplands SvL	finalise botanical identifications analyse data matrices write report to funding agency prepare scientific publications	3/01 - botanical Ids completed 3/01 - complete taxonomic treatment of *Dampiera* June 2001 - report submitted to funding agency 1/02 - scientific paper(s) submitted for publication	report to funding agency Advice to other CALM divisions Advice to external government and non-government agencies Deliver seminars to interested community groups
93/0033	Biological survey of Yanchep National Park AHB	Produce written report for CALMscience	6/02 - submit MS for publication	Scientific paper in CALMscience
93/0034	A biological survey of Cape Arid National Park AHB	Produce written report for regional planning staff.	12/01 - Submit MS for publication	Scientific paper in CALMscience; report to regional planning staff.
93/0035	Biological survey of the southern Carnarvon and northern Irwin Phytogeographic Districts AHB.	Finalise publication of scientific report. Prepare companion volume for the general reader. Carry out liaison/provide advice as necessary.	3/01 - launch scientific report 3/01 - circulate draft of companion volume June 2001 - finalise companion volume	A 600 page report published as a Supplement to the *Records of the WA Museum.* A small companion volume containing the essence of the scientific report, for the intelligent lay reader
93/0037	Floristic survey of the coastal communities of the Warren Botanical Subdistrict NG	Report in CALMscience published, but **retain SPP** until time made available to write further scientific papers.	Dec 2001 - Finalise publication	
93/0038	Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain. NG	Report to AHC finished & sent, but **retain SPP** until time made available to write scientific papers.	Dec 2001 - Finalise publication	
93/0162	Aquatic	Document distribution,	Expect paper describing	4+ papers

	Invertebrate Surveys and Atlas SH	environmental tolerances and taxonomy of aquatic microinvertebrates Laboratory studies using material collected in other projects Groups of particular interest are ostracods, copepods, cladocerans and rotifers	copepods (now accepted) 2/01 - Attend SIL conference 2/01 - Submit paper on distribution of WA ostracods 1/02 - Submit paper on new species of rotifer in WA 1/02 - Submit paper on distribution of cladocerans in WA	clearer understanding of micoinvertebrate biodiversity in WA better information about level of endemism in microinvertebrate fauna information on environmental tolerances of the microinvertebrate fauna
93/0165	Ecological studies Lesueur National Park AH	Analysis and write-up	8/01 - re-compilation of data set (up-dating taxonomy) 12/01 - drafts of two publications submitted 06/02 - drafts of two further publications submitted 12/02 - drafts of two further publications submitted	scientific and technical publications advice to Regional staff and local community groups
93/0166	Floristic survey of the Goldfields woodlands NG	Reports to AHC finished & sent, but **retain SPP** until time made available to write scientific paper.	June 2001 - Provide advice to EPB re mining developments	
94/0003	Conservation of Western Australia's vegetation assemblages AH	Develop and maintain vegetation map database Develop and maintain database of conservation statistics Provide conservation assessment reports to CALM staff and to community organisations	03/01 - up-to-date vege map database published on Data Druid June 2001 - 1:3M vegetation map and memoir published 12/01 - new 1:1M Swan Sheet submitted for publication	scientific publications GIS data sets provided to clients technical reports on database reports on individual conservation assessments as required
98/0008	Taxonomy and zoogeography of aquatic oligochaetes of Australia. AP	Document distribution, environmental tolerances and taxonomy (one paper already published, second in press).	3/01 - third paper submitted June 2001 - fourth paper submitted	knowledge of oligochaete biodiversity, environmental tolerances and biogeography in WA improved
98/0020	Biological Survey of the Agricultural Zone GJK	Final stages of field sampling completed Final identification of invert, vert, flora and wetland collections Compile data matrix, initial analysis prepare draft reports	5/01 - field sampling completed June 2001 - sixth recovery catchment selected 3/02 - Differential GPS, remove drift-fences from biodiversity sites. 11/01 - specimen idents finalised 2/02 - matrices compiled, preliminary analysis run, and seventh and eighth recovery catchments selected. 6/02 - recovery catchments 9 and 10 proposed, write-up commenced	numerous seminars 5 recovery catchments proposed
98/0021	West Midlands Study, Planning for Nature Conservation	Finalise conservation assessment Produce Reports and publications for Scientific Journals Liaiseg with and support community groups in the Region	04/01 - complete conservation assessment June 2001 - complete draft final report for circulation 09/01 - Final Report 2/02 - scientific paper submitted	Study Report (Government Report) Scientific publications Advice to EPA on land clearing applications Data supplied to community group(s) Support for community group(s) on conservation values of Region
99/0001	Biological survey of the Burrup Peninsula SvL	finalise flora chapter co-ordinate other authors to production of report	1/02 - Flora chapter refereed 6/02 - Other chapters of report edited 10/02 - report submitted to	draft funding agency /CALMscience report recommendations for management of Peninsular

			funding agency Dec 2002 - report submitted for publication.	made to Burrup Mgmt Committee
99/0002	Botanical survey of the Pilbara tussock grasslands SvL	complete fieldwork complete specimen identifications, data-basing & data interpretation develop GIS themes	3/02 - specimens identified and data-based 6/02 - draft report completed	funding agency progress reports Advice to other CALM divisions Advice to external government and non-government agencies Benchmark quadrats for central Hammersley Range
99/0003	Biological survey of the Little Sandy Desert SvL	finalise identifications & data-bases Finalise ant identifications Authors to produce manuscripts Compile as single, edited volume	9/01 - Prepare botanical and ant papers 11/01 - All papers in MS 3/02 - Papers refereed & submitted for publication	Seminars as requested Report sent to EA Reserves recommended to Gov't. Interim management advice made to region. Benchmark quadrats for western LSD.
99/0004	Karijini taskforce SvL	Liaison with Mining Companies & Gov't agencies update draft publication	3/02 - report re-drafted 6/02 - New KNP GIS atlas produced	Report Additions to Karijini NP Advice to other CALM divisions Advice to external government and non-government agencies Seminars delivered to interested community groups
99/0014	Directory of Important Wetlands in Australia, 3rd Edition JL	Update 110 existing site descriptions Prepare 4 new site descriptions	1/01 - WA chapter revised; sent to EA 2/01 - Third Edition of Directory published by EA.	Final report (WA chapter of Directory) sent to Environment Australia for publication.
99/0017	Assessment of Biota and Physico-chemistry of Byenup- Muir wetlands JL	Appoint consultant to prepare summary report.	3/01 - receive report fro consultants on 'tolerances of fringing vegetation'. 5/01 - appoint summary consultant 8/01 - completed project	Final summary report to Environment Australia.
99/0015	Tropical inter-tidal benthic invertebrate communities GP	Involving local people, monitor seasonal changes in invertebrate biodiversity of 80-Mile Beach mudflat as a food resource for waders Write paper	3/02 - specimens identified and data compiled. 6/02 - paper in MS	Paper in MS, relating substrate-type, invertebrate biomass and number of shore birds on north-western mudflats
2000/07	Floristic survey of the Darling Scarp NG	Report to AHC finished and sent, but **retain SPP** because needs time to write paper.	Dec 2001 - Analyse data	
2000/0009	Identifying Land with High Nature Conservation Values in the Gascoyne-Murchison Strategy Area AH	Comprehensive assessment of landscape-scale conservation values in region based on existing data Field surveys of biodiversity hotspots Assess individual properties based on GIS analysis of vegetation mapping data Establish monitoring sites on acquired properties	May 2001 - report of comprehensive landscape-scale assessment of G-MS Region Dec 2001 - Final Report on G-MS biodiversity assessment project Dec 2001 - 30 monitoring sites contributed to WARMS 2/02 - scientific publication on regional assessment. As required - conservation assessment reports of properties for acquisition	More than 12 conservation assessment reports to Nature Conservation Division for individual pastoral properties offered for sale, in relation to the rest of the reserve system. Regional biodiversity assessment report Database supplied to G-MS Board and regional groups Scientific publication
2000/0010	An Interim Framework for		6/11 - Complete database with GIS component	Departmental database CD ROM versions of database

	developing a CAR Reserve System for WA AH		9/01 - Final Report Dec 2001 - CD ROM version of database distributed throughout CALM Regions	Project Report(s). Scientific and technical publications. Conservation planning advice to Nature Conservation Division
no spp	Pilbara Regional Survey SH	Prepare scoping paper Prepare SPP	Mar 2001 - Develop proposal	
no spp	Two Peoples Bay publication AH	Up-date manuscripts on physical and biological attributes of reserve.	June 2001 - updated draft papers sent for publication	published report

Anticipated Outcomes (next 18 months):
In the next 18 months, two large current studies will provide regional biodiversity contexts for reserve system design and 'Ecologically Sustainable Development' in the southern Carnarvon Basin and Wheatbelt regions of WA, economically important regions with an array of land-degradation problems. Many of the projects listed in the above table allow the targeting of acquisition of lands for conservation purposes, or selection of areas in which to focus with respect to voluntary conservation agreements etc, because they describe patterns in biodiversity across landscapes. These outputs are particularly relevant to the current purchase program of pastoral properties in the Murchison – Gascoyne region because they form a rational basis for identifying gaps in the comprehensiveness of the conservation reserve system and for selecting optimum areas for efficiently filling these gaps. In the Wheatbelt regions of WA, the biodiversity pattern, species/community habitat preference and conservation status outputs underpin the adoption and management of selected biodiversity recovery catchments and the amelioration of a major threatening process to its biodiversity, part of a 'whole of Government' initiative to conserve the remaining biodiversity in the Agricultural Zone (Salinity Action Plan)..

Adoption Strategy:
Notify and liaise with AgWA, development proponents, land-holders, DEP, DRD and other branches of CALM, on species with conservation problems, areas of high biological value, fire mgmt planning consequences etc as indicated in the above table of projects. Continue to promote findings of the studies through publications, seminars, meetings, committee membership, advice to Nature Conservation Division etc.

Examples include workshops on Stygofauna and scoping parameters for the proposed Pilbara survey, launching and providing a "companion booklet" that deals with implementing the recommendations of the Carnarvon Basin survey book, transferring the echolocation-survey technology to forest regions via the annual mammal course and direct training, ongoing involvement in National Biodiversity Planning Committees such as the National Reserve System's IBRA working group etc.

Performance Indicators
Number of:
- Requests for advice on community/species status issues from Nature Conservation Division
- Requests for advice related to conservation policy issues from Nature Conservation Division
- Reserves recommended/acquired
- Regional and local biodiversity surveys completes; increase in coverage of the State by these surveys
- Scientific and popular papers published on biodiversity issues relevant to WA
- Scientific reports and presentations on biodiversity issues in WA
- Voucher specimens provided to State collections
- Inter-departmental and National committees/working group memberships
- Species conservation or land management problems identified/quantified from surveys
- Amount of external monies obtained for survey projects
- New species/communities described from survey projects
- New occurrences of rare/threatened/vulnerable species discovered during surveys
- Species/communities for which conservation status has been validated by surveys

Partnerships / Collaborators:
A variety of institutions and individuals collaborate in the program's work, including WA Museum (93/0025, 93/0035, 98/0020), University of WA (93/0035, 98/0020), Edith Cowan University (98/0081), R. Bullen (93/0028, 99/0003), Queensland Dept Primary Industries (93/0028), Charles Sturt University (98/0020), WA Agriculture Department (94/0003) and Environment Australia (93/0035).

Staff: Total

	Location	FTE
B. Bromilow (BB)	Karratha	0.7
A.H. Burbidge (AHB)	Woodvale	0.85
A. Clark (AC)	Woodvale	0.7
B. Durrant (BD)	Woodvale	0.6
N. Gibson (NG)	Woodvale	0.9
N. Guthrie (NGu)	Woodvale	0.6
S. Halse (SH)	Woodvale	0.6
A. Hopkins (AH)	Woodvale	0.5
G. Keighery	Woodvale	0.8
J. Lane (JL)	Busselton	0.2
M. Langley (Mla)	Woodvale	0.2
M. Lyons (ML)	Woodvale	1.0
N. McKenzie (NMcK)	Woodvale	0.9
J. McRae (JMcR)	Woodvale	1.0
W. Muir	Woodvale	0.8
G. Pearson (GP)	Woodvale	0.2
A. Pinder (AP)	Woodvale	1.0
J. Rolfe (JR)	Woodvale	0.9
T. Rose (TR)	Woodvale	1.0
P. van Heurck (PvH)	Woodvale	1.0
S. van Leeuwen (SvL)	Karratha	0.6
A. Webb (AW)	Woodvale	1.0
TOTAL		**16.05**

Smaller Projects

	Location	**FTE**
B. Bromilow	Karratha	0.7
A.H. Burbidge (AHB)	Woodvale	0.25
Alan Clarke	Woodvale	0.1
N. Gibson (NG)	Woodvale	0.1
S. Halse (SH)	Woodvale	0.1
A. Hopkins (AH)	Woodvale	0.5
G. Keighery (GJK)	Woodvale	0.1
M. Langley	Woodvale	0.2
Jim Lane (JL)	Busselton	0.2
S. van Leeuwen (SvL)	Karratha	0.6
N. McKenzie (NMcK)	Woodvale	0.3
Grant Pearson (GP)	Woodvale	0.2
Adrian Pinder (AP)	Woodvale	0.1
J. Rolfe (JR)	Woodvale	0.1

SAP

	Location	FTE
A.H. Burbidge	Woodvale	0.5
A. Clark	Woodvale	0.6
B. Durrant	Woodvale	0.6
N. Gibson	Woodvale	0.8
N. Guthrie	Woodvale	0.6
S. Halse	Woodvale	0.5
G. Keighery	Woodvale	0.7
M. Lyons	Woodvale	1.0
N. McKenzie	Woodvale	0.5
J. McRae	Woodvale	1.0
W. Muir	Woodvale	0.8
A. Pinder	Woodvale	0.9
J. Rolfe	Woodvale	0.8
T. Rose	Woodvale	1.0
P. Van Heurck	Woodvale	1.0
A. Webb	Woodvale	1.0

Carnarvon Basin

	Location	FTE
	Woodvale	0.1
	Woodvale	0.1
		0.2

FORESTS & TREE CROPS GROUP

KEY SCIENCE THEME: *Sustainable utilisation of Western Australia's native forests and plantations.* **Science Division** will provide the scientific basis to ensure that the State's native forests and plantation resources are used in an ecologically sustainable manner, which minimizes adverse impacts on the environment. Valid indicators of sustainable forest management will be developed. The information necessary to establish plantations for commercial products and environmental services will be provided.

AIM: To provide the scientific basis for ecologically sustainable forest management systems, and for the cost-effective establishment and management of plantations for commercial and environmental purposes.

PROGRAMS:
Ecologically sustainable forest management
Environmental services
Tree crop development

RELEVANT CORPORATE OBJECTIVES:
To protect, conserve and, where possible, restore Western Australia's natural biodiversity.
To generate social, cultural and economic benefits through the provision of a range of services that are valued by the community and are consistent with the principles of ecological sustainability.
To develop community awareness and appreciation of the biological and physical diversity natural to Western Australia and promote community involvement in and support for its protection, conservation and restoration.

RELEVANT CORPORATE STRATEGIES:
Protect biodiversity from threatening processes, agents and activities, including feral animals, weeds, dieback, and other exotic diseases, salinity and inappropriate fire regimes.
Ensure that the use of wildlife is sustainable.
Manage the forests and woodlands entrusted to us, and the resources they provide, on an ecologically sustainable basis.
Improve community knowledge of biodiversity conservation issues and awareness, understanding and support for CALM's activities, services and policies.
Be responsive to the community.
Partner with agencies and groups with similar interests.

PURCHASERS REQUIRING SERVICES
Sustainable Forest Management
Nature Conservation
Forest Products Commission

Program 1: Ecological Sustainable Forest Management

Output Purchasers: **Sustainable Forest Management Division**
Forest Products Commission

Program Leader **Dr Lachlan McCaw, Manjimup**

Program description and objectives:

This program contributes directly to the objectives of the Sustainable Forest Management Division. These objectives include maintenance and enhancement of biodiversity and sustainable harvesting of products such as timber, from multiple use (State) forests and timber reserves in accordance with approved forest management plans and principles of ecologically sustainable forest management.

The Ecologically Sustainable Forest Management Program integrates a series of related projects that investigate the impact of disturbance (fire and logging) on soil, water yield and quality, microbiota, flora and fauna of the forest. The impact of forest management on the sustainability of the forests will be determined using a system of Integrated Forest Monitoring (FORESTCHECK). Silvicultural management systems will be developed to optimise the productivity from regrowth forests. A study of the regeneration of WA sandalwood in the rangelands and the Departments Vegetation Health Service (Disease Detection) are also located in this program.

The Program has five broad areas of activity (sub-programs) : Forest Management; FORESTCHECK; Fire Management, Sandalwood Ecology and the Vegetation Health Service

Forest Management
This sub-program integrates a series of related Science Project Plans that individually address the response to fire and logging disturbance by vascular plants, invertebrates, small vertebrates, medium-sized mammals, and avifauna. Invertebrates, fungi and other microbiota are thought to comprise about 98 per cent of the biodiversity in Western Australian forests, but have received only limited study to date. Taxonomic and ecological knowledge of many groups of individual species is poor, and the role of microbiota in maintaining ecosystem processes is not well understood. A small number of pest insects and fungi that can cause economically significant losses in native forests and woodlands have been studied in considerable detail. Existing studies of Gumleaf Skeletoniser, Lerps and stem wood borers are being finalised and written up.

Future studies of microbiota will focus on describing and understanding the patterns of biodiversity in the forest, particularly as they relate to environmental factors and forest characteristics such as age, structure and prior disturbance history.

The effects of fire and logging on soil characteristics, and on the yield and quality of water from forested catchments are being assessed at a number of sites in jarrah forest. A series of complementary studies are underway in jarrah forest in the Kingston area north-east of Manjimup where a large multidisciplinary project was initiated in 1994. Harvesting and post-harvest burning is now complete and the project is entering a write-up and monitoring phase.

Research in the karri forest is focussed on the development of even-aged stands following timber harvesting, and on the related responses of flora and fauna, including birds, invertebrates, vascular plants, cryptograms and fungi. Information is obtained from a combination of detailed experimental studies and chronosequence investigations which provide a medium to long term perspective on changes in populations over the life cycle of a karri forest. .

FORESTCHECK
FORESTCHECK is intended to serve as a framework to quantify, record, interpret and report on the status of key forest organisms, communities and processes in response to both forest management activities and natural variation. Monitoring is an essential part of systematic best practice management in order to achieve the objective of ESFM. FORESTCHECK will provide relevant information to judge whether forest biological diversity is being sustained indefinitely, consistent with the objectives of the 1994-2003 Forest Management Plan (LFC 1994). Staff from the ESFM Program will contribute to the design and establishment of FORESTCHECK.

Fire
CALM and the Bushfire Research and Management Group of CSIRO Forestry and Forest Products are collaborating in a major experimental study to determine the effect of fuel age and loading on fire behaviour in the jarrah forest. Two sets of experiments remain to be completed, and analysis of data and development of improved fire behaviour models is progressing. Several issues that are critical to firefighter safety have been identified and widely publicised throughout fire and land management agencies.

A technique for determining past fire frequencies from the occurrence of distinctive black bands on the stems of Balga grass trees is being used to develop fire chronologies for a range of forest and woodland sites in the south-west. A joint project involving CALM and Curtin University to document the history of fire in John Forrest National Park since the time of settlement will be finalised in 2001.

Long term fire ecology research in jarrah forest sites spanning a gradient of average annual rainfall from 800 to 1200 mm is continuing, and three study sites are currently being utilized in a study of the effects of a range of fire regimes on soil carbon and nitrogen.

Sandalwood Ecology
The effects of harvesting, grazing, soil type and vegetation on sandalwood recruitment in the semi-arid pastoral zone are being investigated. Sandalwood population size, structure and recruitment over periods of several decades are being investigated.

Vegetation Health Service (VHS)
The role of the VHS is to provide expertise in the diagnosis and detection of plant diseases, including the detection of *Phytophthora* diseases, leaf diseases, stem and branch cankers (from forest and plantation trees), and nursery diseases. This is achieved by processing of soil and plant samples sent in by various sections of CALM.

Research Objectives:
Forest Management
- To determine the short term effects of logging and associated silvicultural treatments, including prescribed fire, on plants and animals in the jarrah forest.
- To determine the effects of logging and associated silvicultural treatments, including prescribed fire, on the yield and water quality from the jarrah forest.
- To investigate the development of even-aged karri stands following logging and the related responses of flora and fauna, including birds, invertebrates, vascular plants, cryptograms and fungi.
- To evaluate soil organic matter and soil bulk density as potential indicators for ecologically sustainable forest management.
- To develop indicators of regeneration success in native forests appropriate for national level reporting of ecologically sustainable forest management.
- To determine if current forest management practices influence outbreaks of pest insects or fungal disease.
- To devise practical and science-based means of minimizing the development of pest insects or fungal disease in native forests and plantations.

FORESTCHECK
- To monitor the ecological effects of forest management activities in a way that will permit the achievement of ecologically sustainable forest management to be assessed in relation to established criteria and indicators.

Fire
- To compare the long term effects of a range of fire regimes on the structure and floristic composition of jarrah forest understoreys.
- To quantify the changes in fire behaviour in dry eucalypt forest as fuels develop with age, and subsequently revise the algorithms describing the relationships between fire spread, wind speed and fuel load.
- To characterise wind speed profiles in forests with different overstorey and understorey structures
- To reconstruct historical fire frequencies in the jarrah forest using a dating technique based on stems of grass trees, and to interpret historic fire use patterns in relation to environmental and cultural factors

Sandalwood ecology
- Investigate the level of natural sandalwood recruitment on pastoral leases, in the Goldfields and Midwest, and examine the effects of grazing, harvesting and seed enrichment planting on sandalwood recruitment.
- Document sandalwood population size structure and associations with soil type and vegetation in the rangelands.

Vegetation Health Service (VHS
- 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.
- To be aware of diseases which could be a potential threat to plants, especially those of economic or conservation importance.

Significance and Benefits
Forest Management
- The principles of ecologically sustainable forest management require the development and implementation of policies and practices to maintain ecological processes, maintain biodiversity and optimise benefits to the community. There is a strong international focus on the application of criteria and indicators for assessing the sustainability of forest management practices. This sub-program provides important baseline data necessary for the evaluation and ongoing refinement of indicators suitable for Western Australian forest ecosystems.
- This sub-program also provides important information about the response of flora and fauna to disturbance associated with logging and fire. These projects contribute information used in the development of prescriptions, and reporting for ministerial conditions and the RFA

FORESTCHECK
- FORESTCHECK provides a simple, practical, credible and integrated system that will provide information about trends in populations of forest flora and fauna over time in areas subject to a range of management treatments. FORESTCHECK will also contribute to meeting CALM's external reporting obligations in relation to namely Ministerial Conditions on the 1994-2003 forest management Plan, the RFA, and the Montreal Process.

Fire
- Prescribed fire is used extensively in Western Australian forests to meet conservation, protection and silvicultural objectives. Annually, CALM undertakes prescribed burning over more than 100 000 ha of forest. The use of prescribed fire is controversial, with some who claim that it is both ecologically destructive and ineffective in protecting community assets and forest values. There is a need to better quantify the ecological effects of fire regimes and the effects of fuel age and fuel characteristics on fire behaviour. Better understanding of this relationship would allow the consequences of fuel reduction burning to be properly assessed. There is good ecological and historical evidence that fire has long been a feature of south-west forest ecosystems. Knowledge of historical patterns of fire occurrence, coupled with an understanding of fire ecology, Aboriginal fire usage patterns and the role of lightning as an ignition agent should allow fire to be placed in its proper context as an environmental factor.
- Studies of the response of forest communities to repeated fires at different combinations of frequency, intensity and season need to be maintained so that the long term effects of fire are understood and can be managed to achieve desired outcomes.

Sandalwood ecology
- Management practices that encourage the recruitment and re-establishment of Sandalwood in the rangelands are needed to ensure that the species is conserved throughout its range, and that Sandalwood harvesting is ecologically and commercially sustainable.

VHS
- Accurate detection of *Phytophthora* infections is critical to CALM's Dieback Interpreters to assist them in making the operational decisions regarding the boundaries of infected areas, and in selecting road alignments.
- VHS also maintains a comprehensive computerized database of information on the distribution of *Phytophthora* species and their host plants throughout WA.
- Diagnosis of other plant diseases and provision of advice regarding cost effective remedial measures is important for the maintenance of ecosystem health and productive capacity.

Targets/Results Expected:
- Definition of the impact of management practices on soil, water, microbiota, flora, and fauna.
- Development of practical and reliable indicators of sustainable forest management.
- Description of the effect of thinning and fertilization on the productivity of regrowth karri.
- Development of appropriate fire regimes (for biodiversity conservation and protection).
- Improved predictions of the impact of fuel load and environmental conditions on fire behavior.
- A better understanding of the historic fire frequency in WA forests.
- A description of the population structure of sandalwood in the arid zone.

- Development of techniques that enhance the regeneration of sandalwood in the arid zone.
- Provision of timely and accurate disease diagnosis of plant and soil samples from the forest.

Tasks/Activities/Milestones (Science Project Plans)

Ecological Sustainable Forest Management

SPP No	Project Title	Key Activities	Milestones	Outputs
93/0073	Effects of fire regimes on invertebrates in jarrah forest	Finalise manuscript(s) G.Friend contracted to do this	2/01 Submit manuscript to journal	Manuscript containing advice on the effects of fire regimes on invertebrates in jarrah forest
93/0095	Characteristics of hollow-bearing jarrah and marri and their use by selected fauna	Revision of papers following review by journal referees.	2/01 Publication of two papers in external journals (hollow occurrence, and selection of trees for hollow retention). 12/01Publication of paper in Science Division on dimensions of hollows used by fauna.	Predictive models for hollow abundance and dimensions Papers on: Dimensions of hollows used by fauna Hollow occurrence in jarrah and marri trees and Selecting trees to retain for fauna
93/0098	Effects of fire and logging on floristic composition and structure of jarrah forest vegetation	Reassessment of vegetation quadrats and soil disturbance (B.Ward)) Develop and validate database Data analysis and preparation of report	03/01: Complete data entry and assessment of vegetation ,ground cover, and soils. 03/01: Complete data analysis of vegetation data. 04/01: Present results to workshop contributing to revision of the Forest Management Plan 03/01: Submit manuscript for journal publication.	Improved silvicultural guidelines for jarrah forest for low impact logging. Two publications in scientific journals.
93/0106	Increasing productivity of karri regrowth stands by thinning and fertilising	Analyse data from Poole thinning+fertiliser experiment. Prepare draft report on Warren thinning experiment	6/01 Complete analysis of Poole data. 12/01 Complete draft report on Warren experiment.	Report on effects of thinning on growth of high quality regrowth at Warren. Data available for validation of current growth models..
93/0107	Espacement effects on the development and form of regrowth karri stands	Re-measurement of spacing experiment at Wheatley forest block, and analysis of data to determine effects of spacing on tree growth and form	03/01 Re-measurement completed 06/01 Data analysis completed. 12/01 Report submitted to Forest & Wood Products R&D Corporation by 6/01??	eport on effects of initial spacing on tree growth and form as part of WAPIS Regeneration stocking standards project. Modification of silvicultural guidelines as appropriate.
93/0110	Use of phosphonate to determine the effect of *Phytophthora cinnamomi* infection on growth of *Eucalyptus marginata*		12/02 Analyse data to determine suitability for publication	
93/0115	Effects of timber harvesting on terrestrial vertebrates in medium rainfall jarrah forest	Analyse data on habitat use of radiocollared Common Brushtail Possums; and responses of frogs, reptiles, small and medium sized mammals to harvesting;	06/01 Present results to workshop contributing to revision of the Forest Management Plan 06/01 Manuscript on Chuditch bait trial accepted for publication in external journal. 12/01 Publication of paper	Revision of Silvicultural Guidelines and management practices Presentations to CALM and FPC operational staff Contribute to CALM's public information program about the effects of timber harvesting on forest fauna

			on Chuditch recovery and management (Morris *et al.*in press).	by means of written material and oral presentations
97/0007	The impact of timber harvesting and associated activities on the Western Ringtail Possum in Kingston	Prepare a manuscript on survivorship and habitat usage by WRTP.	06/01Completion of radio-tracking of animal experiments 09/01 Present a paper on survivorship of possums to Australian Mammal Society symposium. 06/02 Completion of manuscript on habitat usage by possums	Revision of Silvicultural Guidelines and management Practices Contribute to CALM's public information program about the effects of timber harvesting on forest fauna by means of written material and oral presentations
93/0155	Effects of logging and fire on birds in jarrah forest	Biannual sampling continuing Awaiting a copy of the submitted PhD Thesis and associated data	03/01Paper for CALM sustainability seminar written	Information on effects of fire and logging presented at CALM Seminar on sustainable forest management.
94/0007	Effects of logging on invertebrates in jarrah forest	Biannual sampling continuing Awaiting PhD completion and associated data	12/01 Submit paper to journal	Paper on effects of timber harvesting on invertebrates in jarrah forest
94/0008	Effects of logging on birds in karri forest	Maintain transect lines in a trafficable condition	12/01 Respond to journal review and resubmit paper	Scientific paper and Landscope article describing the results of the karri bird study and outlining the management implications of the study
99/0009	Using ground-based electromagnetic induction to measure forest soil salt storage	Develop internal report into a manuscript for external publication.	09/01 Manuscript completed and submitted for publication	A practical field method for assessing salt storage in forested catchments as required under Ministerial Condition 16 of the 1994-2003 Forest Management Plan.
00/03	Hydrological response to logging in the intermediate rainfall zone of the northern jarrah forest	install hydrological instruments hydrological monitoring ongoing install vegetation transects pre & post logging surveys logging treatments post logging silvics and burn data analysis	12/01 completion of harvesting and follow up silvicultural work, including post-harvest burning. 12/01 Complete analysis of data from summer 00/01 period 6/02 Internal report to Director, CALMScience	A report and scientific papers describing the effectiveness of measures used to protect water quality and nature conservation values during timber harvesting operations in the intermediate and low rainfall zones, as required under Ministerial Condition 12 of the 1994-2003 Forest Management Plan.
TBA	Sustainability indicators for Western Australian soils (WAPIS-funded project for indicators 4.1 d & e)	Collection of field data Analysis and reporting of data	3/01, Define relationships between disturbance SOM and Bulk Density. 9/01 Submit final report to Forest & Wood Products R&D Corporation	Written report on the use of soil organic matter and soil bulk density as indicators of sustainable forest management. Contribution to national project on Montreal criteria and indicators Increased knowledge and technical expertise in the use of these indicators in the forests of WA
TBA	Forest Health (R.Robinson and J.Farr – to assist FMB)	Develop and review methods Train staff involved Diagnosis	Set by SFM Director	Set by SFM Director
TBA	Standardised measures of regeneration	Evaluate alternative methods of regeneration stocking in	2/01: participate in project workshop in Melbourne, and report on WA	Report describing the development of standardised measures of

	success for sustainable forest management in native forests (WAPIS-funded project for indicator 2.1 g)	representative areas following harvest.	component of work. 10/01: final report submitted to Forest & Wood Products RDC.	regeneration success for major forest types that can be used to aggregate information for reporting at regional and national levels for the Montreal process.

Microbiota

SPP No	Project Title	Key Activities	Milestones	Output
93/0021	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	Prepare manuscript for publication.	3/01 Finalize and submit manuscript for publication	Paper on earthworm fauna in an urbanized landscape submitted to science journal
93/0097	Control of Jarrah leafminer: Selective retention of JLM resistant trees and ground coppice in a demonstration forest plot	Prepare manuscript for publication.	12/01 Finalise and submit manuscript for publication	JLM-susceptible coppice and saplings removed Reference photographs
93/0103	Quantitative population monitoring of Gumleaf skeletonizer *Uraba lugens* and impact assessment on jarrah crowns	Finalize and submit manuscript for publication.	03/01 Submit manuscript on biology of *U. lugens* for internal review by 06/01Complete draft on GLS population monitoring by	External journal paper on biology of *U. lugens* for publication Journal paper on outbreak of *U.lugens* for publication
93/0104	Distribution of Gumleaf skeletonizer in the central and southern forest regions.	Finalize and submit manuscript for publication.	6/01 Completed draft	Submit paper on distribution for publication
93/0105	The influence of pheromones in the mating behaviour of Tryphocaria acanthocera (Coleoptera: Cerambycidae)	Finalize and submit report.	09/01Complete draft by August 2001 (results unsatisfactory for external publication).	Report on potential of pheromone traps for limiting attack of T. acanthocera in Karri regrowth stands
95/0001	Chemical control of Armillaria	Prepare manuscript on biocontrol of ARD	2/01 manuscript submitted for internal review	Scientific paper on effectiveness of biocontrol and chemical treatments.

98/0006	Below ground incidents of *Armillaria luteobubalina* in regrowth karri	Analyse data on below ground incidence of ARD data Prepare manuscript on below ground incidence of ARD Write up the analyses of the impact of thinning on ARD and the effect of ARD on growth in the Warren Thinning Trial.	3/01 Manuscript on below ground incidence of ARD submitted for internal review. 2/01 Initial draft of manuscript on ARD in Warren Thinning Trial 11/01 Seminar on ARD in Karri.	Scientific paper on below ground ARD Scientific paper of ARD in relation to thinning intensity in Karri. Seminar on ARD in karri regrowth forest
98/0015	Effect of fire on the fruiting of fungi on karri regrowth forests	Establish study in field Collect data on chrono sequence of fungal fruiting bodies following fire	03/01 Report prepared 06/01 Finalise data analysis. 06/01 Draft manuscript submitted for internal review. 09/01 Presentation to Fire Seminar	Scientific paper Landscope article submitted 12/00. Chapter for book on Fire in South-west Australian Ecosystems growth
Concept Plan	Retrospective study in karri on the effects of logging and fire mgmt on biodiversity & ecosystem attributes (Fungi, Cryptogams, Invertebrates inc Earthworms, soil attributes)	Select Sites Develop methods and decide Sampling dates Survey out study areas Develop maps of sites Submit SPPs	03/01 Submit SPPs 06/01 sites chosen, survey study areas and develop site maps 07/01 initiate data collection	Reports on each attribute studied Seminars on significant findings Scientific papers
TBA	The effects of Logging and Macrofungi in karri regrowth forests (Richard Robinson)	Submit SPP Select sites Survey study areas Data collection	03/01 submit SPP for approval 06/01 Sites selected, plots surveyed, data collection initiated 09/01 data analysed 12/01 report prepared 03/02 draft paper	Report Scientific paper Seminar Voucher collection for herbarium
TBA	The effects of Logging and fire management on Cryptogams in karri regrowth forests (Ray Cranfield)	Submit SPP Select Sites Survey study areas Data collection	03/01 submit SPP for approval 06/01 Sites selected, plots surveyed 09/01 data collection initiated 12/01 data analysed, report prepared 03/02 draft paper	Report Scientific paper Seminar Voucher collection for herbarium
TBA	The effects of Logging and fire management on Foliar Insects and Gondwanan Invertebrates in karri regrowth forests (Janet Farr)	Submit SPP Select Sites Survey study areas Data collection	03/01 submit SPP for approval 07/01 Sites selected, plots surveyed, data collection initiated 09/01 data collection 12/01 data analysed, report prepared 03/02 draft paper	Report Scientific paper Seminar Vouchers added to insect collection
NEW PROJECT	Landscape and fire management interactions and their effects on invertebrate biodiversity in the northern jarrah forest (I Abbott)	Prepare SPP Select study sites Commence sampling Establish database	6/01 Submit SPP for approval 6/01 Select study sites 12/01 Commence sampling 3/02 Establish database	Approved SPP Study sites ready for sampling Database

RPP 24/86	The impact of repeated defoliation's on the wood growth of jarrah saplings	Remeasure sapling diameter each December and update graph.	3/01 Remeasure saplings diameter in December and update data.	Updated graph showing difference in growth of undefoliated and defoliated saplings
TBA	Mundella Yellows (MY) syndrome in Western Australia	Survey incidence and monitor spread of MY in urban and rural ecosystems.	12/00 initial survey; samples sent to University of Adelaide for testing. 3/01 Prepare and submit article for *Landscope*. 12/01 Survey and 18 months' observations complete; review status and write report.	*Landscope* article. Occurrence of MY documented. Progress Report

Fire Management

SPP No	Project Title	Key Activities	Milestones	Outputs
93/0099	Fire regime effects on the structure and floristics of jarrah forests	Maintain schedule of treatments to plots at McCorkill and Yendicup forests.. Implement a series of 1m x 1m quadrats to assess differences in species richness and abundance between treatments. Prepare a draft ms	03/01: implement scheduled burning treatment 06/01: establish additional sampling quadrats. 9/01 Presentation to Fire Seminar	Annual progress reports to CALM & to external funding agencies Annual seminars for operations staff Interactive database listing ecological attributes & fire re-sponse of plants in south-west forests & shrublands Paper on effect of repeated fire on floristics & structure of jarrah forest understorey at three contrasting sites Paper on time to first flowering & seed production for selected plant species in jarrah forest
96/0010	Fire history and impact of *Phytophthora cinnamomi* in jarrah forests	Data analysis, and preparation of manuscript	6/01 Complete data analysis. 9/01: Submit draft manuscript for internal review. 12/01 Submit manuscript to external journal.	Annual progress reports to CALM and to external funding agencies Manuscript for publication in external journal Annual seminars for operations staff
93/0099	Fire regime effects on the structure and floristics of jarrah forests	Maintain schedule of treatments to plots at McCorkill and Yendicup forests.. Implement a series of 1m x 1m quadrats to assess differences in species richness and abundance between treatments. Prepare a draft ms	03/01: implement scheduled burning treatment 06/01: establish additional sampling quadrats. 9/01 Presentation to Fire Seminar	Annual progress reports to CALM & to external funding agencies Annual seminars for operations staff Interactive database listing ecological attributes & fire response of plants in south-west forests & shrublands Paper on effect of repeated fire on floristics & structure of jarrah forest under-storey at 3 contrasting sites Paper on time to first flowering & seed pro-duction for selected plant species in jarrah forest

96/0010	Fire history and impact of *Phytophthora cinnamomi* in jarrah forests	Data analysis, and preparation of manuscript	6/01 Complete data analysis. 9/01 Submit draft manuscript for internal review. 12/01 Submit manuscript to external journal.	Annual progress reports to CALM and to external funding agencies Manuscript for publication in external journal Annual seminars for operations staff
97/0008	A fire history of John Forrest National Park, Perth, WA Joint project with Curtin University (Prof, B. Lamont	Fieldwork cleaning grasstrees in JFNP to reveal fire history. Library research into social aspects of fire history. Recorded interviews with some old local inhabitants, rangers	06/01 Complete library and interview work and submit final report to CALM.	Comprehensive final report on Fire History of John Forrest National Park to CALM & SPIRT
97/0003	Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest	Complete final series of experimental fires at Dee vee Road in conjunction with spotting study, January 2001. Analyse data on fuel characteristics, fire spread and bark consumption and prepare draft manuscripts.	03/01 complete field work at Dee Vee Rd. 06/01 present conference paper on fuel characteristics (Perth). 09/01 present conference paper on bark consumption (Christchurch). 09/01 submit manuscript on actual rate of spread compared with predictions from current behaviour guides.	Annual progress reports to CALM and to external funding agencies Annual seminars for operations staff A revised fire behaviour prediction system for dry eucalypt forests. Quantification of the fire suppression benefits of fuel reduction burning. Improved guidelines and training information for firefighter safety.

Sandalwood Ecology

SPP No	Project Title	Key Activities	Milestones	Outputs
96/0006	Field ecology of Western Australian Sandalwood (*Santalum spicatum* (R.Br.)A.DC.) impact of land mngt activities on sandalwood recruitment	Assess sandalwood recruitment trials in the Midwest & Goldfields Develop a system to monitor sandalwood recruitment after harvesting	03/01 Finalise analysis of sandalwood inventory & recruitment data 06/02 Establish sandalwood recruitment monitoring plots in areas to be harvested	Paper on the effect of management regime on sandalwood recruitment Paper on the influence of land types on sandalwood stocking

Vegetation Health Service (VHS)

SPP No	Project Title	Key Activities	Milestones	Outputs
N/A	Provision of *Phytophthora* (dieback) diseases detection and general plant disease diagnostic service to CALM	Processing of plant and soil samples for fungal pathogen detection and identification	On-going support to Dieback Interpreters (production of hygiene maps) A dynamic Corporate database of *Phytophthora* distribution in WA	Results of pathogen assessments on plant and soil samples throughout WA Annual open day for CALM's Dieback Interpreters to find out about the operations of the VHS and to learn about *Phytophthora*

Outcomes

Forest Management:

Silvicultural specifications for timber harvesting in jarrah forest have, and will continue to be updated to provide improved guidelines to protect habitat for fauna that may be adversely impacted by harvesting operations.

The importance of fox predation in limiting populations of medium-sized mammals has been demonstrated, and predator control programs will be developed and enhanced to optimise effectiveness.

Jarrah silvicultural guidelines will be refined to minimise adverse impacts on soils and understorey vegetation.

Ecological and silvicultural characteristics of even-aged stands of Karri at different stages of stand development will be documented, and the responses to silvicultural treatments will be quantified.

Science-based advice will be available to managers to make informed decisions about potential threats to ESFM from pests and diseases, and about possible management interventions to limit the undesirable effects of pest and disease outbreaks.

FORESTCHECK
Forest managers will be provided with information to assess the achievement of ecologically sustainable forest management, and that can be used to develop adaptive management practices.

Fire Management
Fire management practices that are based on a sound scientific understanding of fire behaviour and the effects of fire on ecosystems. Where appropriate, fire regimes similar in frequency, intensity, season and scale to those that existed prior to European settlement may be implemented.

Sandalwood ecology
A sustainable sandalwood harvesting industry that conserves the species throughout its natural range and provides economic benefits to Western Australia and to communities in the pastoral zone through efficient utilisation of Sandalwood for high-value end uses.

VHS
Management guidelines and operational decisions are based on a sound knowledge of the disease status of forests plantations and nurseries.

Adoption/Uptake Strategy:
- Important new findings from the study are discussed with District, Regional and Forest Product Commission staff as a preliminary step to revising silvicultural specifications. Where appropriate, changes may be made to the specifications described in the manual for Timber Harvesting in Western Australia.
- New techniques are presented to timber industry contractors and CALM field personnel and FPC personnel in training sessions, workshops and field days
- Findings likely to stimulate a change in planning procedures or policy are presented to senior staff in seminars and field days.
- Results are published in recognised national, and where appropriate, international scientific journals.
- Findings from research experiments will provide the basis for a revision of Management Plans, Silvicultural Guidelines, Manuals, Forest Fire Behaviour Tables, Wildfire Threat Analysis System etc
- Information on the disease status of plant and soil samples is passed directly to CALM officers (eg. Dieback Interpreters, plantation and nursery officers) and others who send samples for diagnosis. In addition open days are held for field officers so that the information on disease status can be disseminated and used to the greatest advantage.

Partnerships/Collaborators:
Where appropriate and as the opportunities arise we will develop a co-operative Western Australian approach to research and development related to Ecologically Sustainable Forest Management by developing joint funding proposals to prospective sources with partners from other institutions (e.g. Universities, Agric WA, CSIRO). Where the expertise for particular projects is lacking or where there are significant advantages in collaborative projects specific CALM funded projects will be developed with other agencies.

Staff:

ESFM		
Staff	**Location**	**FTE**
I.Abbott	Como	0.05
J. Brand	Como	0.5
T. Burbidge	Como	1.0
N D'Souza	Como	0.4
F Tay	Como	1.0
D. Ward	Como	1.0

J Webster	Como	0.6
A. Wills	Como	1.0
J. Kinal	Dwellingup	1.0
K. Whitford	Dwellingup	1.0
J. Farr	Manjimup	1.0
G. Liddelow	Manjimup	0.8
L. McCaw	Manjimup	0.95
J. Neal	Manjimup	1.0
R. Robinson	Manjimup	1.0
J. Rooney	Manjimup	1.0
R. Smith	Manjimup	1.0
B. Ward	Manjimup	0.8
C. Ward	Manjimup	0.9
A. Wayne	Manjimup	0.9
I. Wheeler	Manjimup	1.0
Total		**17.9**

Program 2: Environmental Services

Output Purchasers: **Nature Conservation**
Sustainable Forest Management
Forest Products Commission

Program Leader: **Dr Margaret Byrne, Kensington**

Program description and Objectives:
Description
The Environmental Services Program provides the essential genetic, silvicultural and land capability information needed to underpin the management of established tree crop and plantation species, and the development of new tree crops for lower rainfall areas. Through the activities of this program the State Salinity Strategy will be supported by the widespread adoption of tree crops in agricultural landscapes to assist in reversing the process of salination

The Program has three broad areas of activity, sub-programs : Genetic Resources and Tree Breeding; Tree Crop Management; and Tropical Plantations

Genetic Resources and Tree Breeding
The Genetic Resources and Tree Breeding sub-program provides a range of genetic and breeding research for tree species in farm forestry, plantations and native forests. Farm forestry has enormous potential to address the significant environmental degradation caused by dryland salinity. Knowledge of genetic diversity and genetic structuring are important for the efficient domestication and utilisation of native species. Many species with potential for farm forestry are species complexes where the genetic entities and their relationships require identification before they can be developed effectively. Selection, breeding and improvement programs focused on commercial traits will increase the productivity and feasibility of farm forestry activities. Genetic diversity studies will also enable appropriate conservation of natural gene pools of these species.

Tree breeding and deployment of the main commercial plantation species is the responsibility of the Forest Products Commission but CALM provides some tree breeding and genetic marker technology services to FPC as required. Breeding for wood density in *E. globulus* is currently carried out by Science Division and CALM has extensive genetic variation trials of a number of eucalypt species. Genetic marker technology is used to improve the efficiency of advanced breeding programs through assessment of diversity maintained in breeding programs, fingerprinting of clones and control pollinated families, identification of parent trees to maximise diversity in crossing programs and monitoring of gene flow in seed orchards.

Jarrah dieback, caused by infection of *Phytophthora cinnamomi*, is a significant disease in southwest Western Australia. Identification of dieback resistance and development of seed orchards for production of dieback resistant germplasm will facilitate rehabilitation of dieback affected sites in the Jarrah forest.

This project maintains close interaction with the Tree Breeding and Genetic Deployment section of the Plantations Operations Division of FPC to ensure the rapid deployment of new and improved genotypes.

Tree Crop Management
The Tree Crop Management component of the program covers the areas of: site evaluation systems for plantation and tree crops; establishment and stand management; pests and diseases.

By developing an understanding of the factors (soils, geomorphic, climatic) which influence the survival and performance of tree crops, systems that predict growth and water use of tree crops and plantations will be developed. New technologies for assessing site attributes such as ecohydrological models (i.e. TOPOG), remote sensing and geophysical techniques for predicting development of salinity will be evaluated

Predictions of the nutrient requirements and stand densities required to optimize growth and survival will be developed from an understanding of the interaction between stand density, fertilizer inputs and tree performance. This will result in the development of management systems (site-specific silviculture) which allow the tailoring of silvicultural practices to site conditions.

Similarly this research will determine the best placement of trees on farms to optimize profitability and water use and determine whether fast-growing strips of trees can rapidly de-water landscapes.

The selection and development of a range of multiple purpose tree species will allow large-scale revegetation to occur. This takes into account potential tree performance and products and operates on the assumption that large-scale tree planting will not occur unless there is are commercial drivers (as seen with *Eucalyptus globulus*). The development of an oil eucalypt industry (Tree Crops Development Program), assessment of the performance of sandalwood and assessing a range of tree crops for their potential to fix greenhouse carbon are examples of developments in this area.

On an opportunistic basis the impact of pests and diseases (invertebrate and vertebrate) on the performance of plantation species (*E. globulus, P. radiata, P.pinaster)* will be determined

Tropical Plantations
This project was initially established as an ACIAR collaborative project in late 1992. The initial 3 years were strongly influenced by the need to provide operational outcomes. The parasitic habit of *Santalum album* increases the complexity of plantation silviculture compared to traditional monoculture plantations. Host species is the single most important factor influencing plantation *S. album* survival and growth, thus the selection of the host species is critical. To date the project has identified suitable pot and intermediate hosts for *S. album* and has provided fundamental information on early rotation silvicultural issues. These include pot size and type, time of introduction of pot host, host species propagation requirements, site preparation, weed control, seed collection and storage, seed germination, parasite: host ratios, parasite: host stand densities.

The future of the project will be linked to the success of an application to ACIAR for a joint project between CALM and the Institute of Wood Science and Technology at Bangalore in India. The negotiations for the project are almost complete with only a final approval from India required for the project to proceed. Future research will concentrate on mid-rotation issues, oil yield, growth and yield data and provenance selection.

Objectives:
Genetic Resources and Tree Breeding
- Optimize the production of wood and non wood products through:
- Selection and breeding of superior tree genotypes for important traits such as growth, form, wood density, and oil production and salt tolerance.
- Use of genetic markers to validate breeding programs, identify diversity in crossing programs and monitor seed orchard performance.
- Investigation of patterns of genetic diversity and genetic relationships within species complexes being developed for commercial farm forestry.
- Selection of dieback resistant lines of Jarrah and establishment of seed orchards to provide improved dieback resistant germplasm.

Tree Crop Management
- To develop systems which allow the integration of trees into farmland and farming systems in the <600 mm rainfall zone by:
- Developing practical site evaluation systems (site quality models)
- Optimising the growth performance of trees by determining the most suitable species, best

establishment techniques and best management practices

- Developing growth and yield models as planning tools and to allow comparisons between alternative species or management regimes.
- Developing biomass prediction equations to allow inventory of carbon stocks in farm plantings for carbon credit trading.
- Developing carbon sequestration models for planning and comparing alternative planting/management scenarios.
- Determining the best distribution of trees to maximise their water use and thus salinity control.
- Developing practical management strategies which optimize the profitability and sustainability of trees established on farmland.
- Developing strategies which take into account present and future risks to farm forestry from pests and diseases.
- Investigating establishment techniques, long-term growth and host relationships of sandalwood on farmland in south-western Australia.
- Identifying superior sandalwood provenances with desirable characteristics, such as high oil content and fast growth.
- To maximise the wood production from high rainfall state owned and managed plantations by:
- Understanding the nature of interactions between site (soil, hydrological and climatic) properties and *Eucalyptus globulus* performance (survival and growth) on farm-land in the >600 mm rainfall zone.
- Devising practical management strategies (fertilizer programs, safe stand density limits) which optimize the profitability and sustainability of *Eucalyptus globulus* plantations established on farmland.
- Devising strategies which take into account present and future risks to *Eucalyptus globulus* plantings from pests and diseases.
- Providing soil and plant laboratory services to support this and associated programs in CALM.
- Optimising wood production by the provision of appropriate weed control, fertilizer and thinning prescriptions for plantations at all stages of the rotation based on the results of silvicultural trial work on a wide range of sites.

Tropical Plantations

- Providing a reliable and routinely used *Santalum album* silvicultural system (nursery and field) for Cununurra clay and Cockatoo Sand sites within the Ord River Irrigation Area.
- Identify other potential high value timber species, either for use within *S. album* plantations as long term hosts or as 'stand-alone' plantation species.
- Development of a refined *S. album* : *Alternanthea nana* propagation system.
- Identifying of suitable *S. album* intermediate hosts.
- Determining optimal spacing designs and optimal host parasite ratios for sustained plantation growth of *S. album.*

Significance and Benefits

Genetic Resources and Tree Breeding

- Significant gains in commercial traits can be made from through tree breeding and improvement programs. The development and utilisation of genetically improved germplasm will increase the viability and productivity of commercial farm forestry and plantations. Application of genetic marker technology will improve the efficiency of breeding programs and maximise the genetic gains to be made.
- Knowledge of genetic resources enables efficient development of species with commercial potential for farm forestry. The utilization of species complexes requires the identification of genetic entities and their relationships before selection and breeding are feasible. Definition of provenance variation will facilitate selection of superior genetic material. This knowledge will also enable the appropriate conservation of natural gene pools of these species.
- The production of dieback resistant Jarrah seed will enable rehabilitation of dieback affected sites in the Jarrah forest. These sites will be foci for increased dieback resistance in the surrounding forest area.

Tree Crops Management

- This project will result in increased adoption of tree cropping outside the traditional plantation areas in southern WA by:
- Improving the performance (growth, survival) of tree crops in the <600mm rainfall zones.
- The demonstration of successful farm forestry systems will encourage investment in this area, and make a significant impact on solving farm-land degradation caused by salinity and wind erosion in the<600 mm rainfall zone.

- The provision of practical sandalwood establishment techniques for the Wheatbelt will lead to the establishment of commercial size plantations for timber production.
- The provision of improved silvicultural management systems for softwood and hardwood plantations in the > 600 mm rainfall zone will ensure that the FPC's plantations are performing at their potential. Expenditure on fertilization will be based on response data on a site by site basis. The aim is to ensure that silvicultural activities are both timely and economic.

Tropical Plantations

Santalum album (Indian Sandalwood) is perhaps the most commercially important of the 16 Santalum species. Western Australia has maintained an entirely export orientated sandalwood industry since mid 1840, based on the native *Santalum spicatum*. This industry generates approximately 10% of the FPC's revenue. The general move away from the exploitation of native timber species to the development of plantation resources gives impetus to *S. album* silvicultural investigations within the Ord River Irrigation Area, northern Western Australia.

This project will deliver information on Santalum: host relations, which are fundamental to understanding the silvicultural complexities of *S. album*. The project has immense practical implications and urgent demands due to considerable commercial activity and the development of private sector plantation programs.

Targets expected results

- Improved genotypes that maximises productivity from plantations and tree crops
- Identification of genetic diversity in species developed for commercial farm forestry.
- Validation of breeding and crossing programs, and seed orchard performance.
- Productive and dieback resistant jarrah that can be used in plantations and forests
- Refined silvicultural systems that maximize production from existing plantations
- Improved potential of new tree crop species for the medium rainfall zone (MRZ) (e.g. WA sandalwood and a range of eucalypts for sawlog production).
- Accurate site selection system for Maritime pine in the medium rainfall zone.
- Practical and effective carbon accounting systems for tree crops and plantations.
- Tree planting layouts and arrangements that provide control of ground water.
- Refined silvicultural systems for Indian sandalwood in the Ord River Irrigation area.

Tasks (SPPs), Activities, Milestones, Outputs

SPP No	**Project Title**	Key Activities	**Milestones**	**Outputs**
Genetic Resources and Tree Breeding				
93/0131	Assessing wood quality of *E. globulus* breeding selections.	Core sampling of EG30 and king island population to determine genetic variation	03/01 Coring and laboratory processing completed 06/01 Data analysis completed 12/01Submit report to FPC	Report to FPC, Draft paper on the genetic variation in wood density of *E. globulus*
93/0126	Genetic variation in quantitative traits of exotic and endemic plantation and rehabilitation species.	Write up C. maculata trials Analyse + Write up *E.viminalis* trials Establish ALRTIG trials *E.maculata, E.sideroxylon, E.tricarpa, E. occidentalis and 2 E. cladocalyx* trials Measure 2 *E.muellerana*, up to 4 *E. botryoides, 1 E.saligna* trial and 2 *E.viminalis* trials. Index selection for establishment of grafted seed orchards.	03/01 Paper on *C.maculata* written 06/01 Paper on *E. viminalis* written 12/00 Sow seed for 2001 trials 03/01 Site selection complete 06/01 Trials assembled in Nursery, sites pegged 09/01 All ALRTIG trials established, reports written 06/01 Bridgetown *E. viminalis* and *E.saligna* trial at Willowdale measured 06/01 Data entered and	Submit to paper to journal Progress report to ALRTIG Report on selection data to FPC for scion collection

			analysed, and selections made for grafted seed orchards 9/01 Measure *E.viminalis* trial at Wellington 03/ 01 Measure *E. botryoides* – Huntly 3/01 Measure *E. botryoides* at Wellington, Worsely and Busselton 6/01 Measure E.muellerana trials? 9/01Data entry and analysis	
93/0112	Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*.	Establish clonal DRJ (Dieback Resistant Jarrah) seed orchard at seed orchard centre [NHT project]. Test progeny of early DRJ plantings for resistance to *P. cinnamomi*; compare seedling-inoculation methods for DRJ selection; and select additional DRJ lines for propagation (pot trials). [NHT project]. Field DRJ validation trials (clones) planted and inoculated in 1999 - monitor survival and test dead plants for *P. cinnamomi* infection. Write up early DRJ clonal validation trial.	6/01 production of DRJ clones for 2001 planting. 06/01 Finalise design of seed orchard; site preparation; pegging complete; order DRJ clones for 2002 planting. 9/01 Plant first stage of seed orchard. 9/01 Write and submit progress report. 3/02 Monitor survival of orchard trees. 6/02 Production of DRJ clones for 2002 planting. 06/02 Finalise stage 2 design of seed orchard; site preparation; pegging. 3/01 Sow seed for 2001/02 trials. 09/01 Finalise trial designs and set up (re-pot). 9/01 write and submit progress report. 12/01 Complete inoculation of trials. 3/02 Collect and sow seed for further trials (if available). 06/02 Trials measured. 6/02 Data analysed; DRJ seedlings for propagation selected. 06/01 Survival and growth monitored, test for P. cinnamomi completed. 9/01 Data analysed; reject DRJ lines culled. 06/02 as above. 06/01 complete and	First stage of DRJ production seed orchard established. Progress Report to NHT. Progress Report to NHT. Report on Improved DRJ selection methods. DRJ provided to Alcoa for propagation. DRJ clonal lines that pass validation test - for use in seed orchards; Rejects - culled from program. Journal paper on field survival and growth of DRJ.

			submit paper to journal.	
94/0006	Dieback resistant jarrah (DRJ) establishment in operational forest rehabilitation sites	Mapping and survival assessment of DRJ plantings in forest.	12/01 DRJ plantings assessed and mapped.	Progress report.
95/0014	Vegetative propagation by grafting of dieback resistant jarrah for seed orchard establishment. (SPP reinstated – NHT grant).	Develop grafting techniques for use with dieback resistant jarrah (DRJ) [NHT project].	3/01 Sow seed for rootstocks; select DRJ clones for trials. 9/01 Commence grafting trials using DRJ clones as scions. 9/01 write and submit progress report.	Progress Report to NHT. Report on technique for grafting jarrah (for application to DRJ lines that are difficult to propagate by tissue-culture), for seed orchard establishment.
98/0007	Genetics and molecular biology of tree species.	1. Determine genetic structure in Sandalwood. 2. Identify genetic and taxonomic entities in *Melaleuca uncinata*. 3. Investigate provenance effects in *Eucalyptus occidentalis*. 4. Determine genetic diversity in *Pinus brutia* stands in Australia. 5. Investigate genetic patterns in *Acacia microbotrya*.	03/01 Analysis of genetic structure in Sandalwood completed and report to FPC written. 06/01 Journal paper on genetic structure in Sandalwood written. 09/01 Analysis of genetic entities in *M. uncinata* and completed report for NHT written. 12/01 Analysis of provenance effects in *E. occidentalis* and genetic diversity in *P. brutia* completed and reports to NHT, FPC & ALTRIG written. 03/02 Journal paper on genetic entities in *M. uncinata* written 06/02 Analysis of genetic patterns in *A. microbotrya* completed and report to FPC written.	1. Report and journal paper on genetic structure in Sandalwood. 2. Report and journal paper on genetic entities in *M. uncinata*. 3. Report and journal paper on provenance effects in *E. occidentalis*. 4. Report and journal paper on genetic diversity in Australian stands of *P. brutia*.
Tree Crop Management				
98/0002	Establishment of sandalwood (*Santalum spicatum*) tree farms in south western Australia.	Monitor sandalwood host and stocking rate trials at Narrogin, Katanning & Dandaragan Monitor jam (*A. acuminata*) provenance trials and sandalwood provenance trials in the Wheatbelt	6/01 Complete paper on the effect of host species and stocking rate on sandalwood performance at Narrogin 6/01 Establish sandalwood provenance trials in the Wheatbelt 4/02 Establish sandalwood next to jam provenance trials at Morawa, Dowerin and Corrigin 6/02 Establish A. microbotrya	Paper on the effect of host species and stocking rate on sandalwood performance at Narrogin Complete a preliminary report on the influence of jam provenance type on sandalwood performance.

			provenance trials in the Wheatbelt. 6/02 Preliminary report on the influence of jam provenance type on sandalwood performance.	
TBA	Maritime Pine yield study	Develop empirical model to reliably predict the growth and yield of *P. pinaster* established on farms from site attributes and management factors.	07/00. Complete field sampling. 03/01. Stem volume equations for *P. pinaster* on farmland 03/01. Complete processing of stem analysis data. 04/01. Complete processing other data. 06/01. Produce Site quality model. 07/01. Refine volume growth model (include effects of spacing, planting arrangement, thinning). 09/01. Complete evaluation of effects of *P. pinaster* on soil conditions (acidity, organic carbon, EC_a (salinity)).	Brief publication on volume equations (or include in larger publication). Report & publication on yields of *P. pinaster* on farms (block & belt plantings). Site quality model for FPC Publication of site quality model. Refined volume growth functions in *P. pinaster* carbon sequestration model. Publication(s) on effect of *P. pinaster* on farmland soils.
TBA	Maritime Pine biomass and carbon study	1. Develop biomass prediction equations to reliably predict tree biomass and carbon mass from easily measured tree dimensions. 2. Develop stand-level empirical model of carbon sequestration of *P. pinaster* on farmland.	01/01. Complete field sampling biomass & litter on destructive sample plots. 02/01. Complete processing & analysis of individual tree biomass data. 03/01. Complete initial analysis litter data. More sampling if required. 06/01. Refinement of carbon sequestration model for *P. pinaster* stands.	Publication on biomass and carbon prediction in *P. pinaster* individual trees Publication on biomass & carbon prediction in *P. pinaster* & *E. globulus* litter. Ongoing presentation of latest version of stand-level carbon sequestration model (*P. pinaster*) to FPC. Publication of stand-level carbon sequestration model for *P. pinaster.*
TBA	Bluegum biomass and carbon study	1. Develop biomass prediction equations to reliably predict tree biomass and carbon mass from easily measured tree dimensions. 2. Develop stand-level empirical model of carbon sequestration of *E. globulus* on farmland.	03/01. Complete processing & analysis individual tree biomass data. 06/01. On-going refinement of carbon sequestration model for *E. globulus* stands.	Publication on biomass and carbon prediction in *E. globulus* individual trees Publication on biomass & carbon prediction in *P. pinaster* & *E. globulus* litter. Publication of stand-level carbon sequestration model for *E. globulus*
TBA	Evaluation of root sampling strategies (CRC Greenhouse	1. Quantify the horizontal and vertical root distribution, and	06/01. Complete sampling of 4 trees. 08/01. Complete	

	Accounting study)	total root biomass, of sample trees representative of reforestation in Australia. 2. From simulated sampling evaluate alternative sampling strategies for accuracy (bias & precision) efficiency.	simulations & analysis of results..	
TBA (SPP submitted)	Early rotation nutrition and silviculture of pines on ex-farmland.	Continue monitoring existing experiments. Initiate work to investigate the influence of nitrogen on the growth and form of *P. pinaster*. Data analysis for initial phase of the experiment.	03/01 Establish two form pruning experiments. 06/01 Results from initial NPK interaction experiments writing-up. 06/01 Initiate widespread form assessment of *P. pinaster* plantations.	
TBA (SPP submitted)	Water use and nutrition studies of *P. pinaster* in the medium rainfall zone	Measure soil water, tree water status and growth on three sites across the MRZ Commence data analysis Evaluate data requirements for model development	6/2001 Complete fourth year of measurements 12/2001 Complete preliminary data analysis	12/2001 Draft manuscript of first phase of study
93/0152	Use of heat pulse methodology to measure sap flow in pine spp.	Collect sapflow and leaf area data Collate data Calculate sapflow and analyze data	03/01 Leaf areas recalculated using standardized technique 3/01 Complete HPV calculations, scale to stand basis 12/01 MS on Water use, leaf area and growth of *Pinus pinaster* and *Pinus radiata* written	Paper on likely effect of manipulating leaf area on water demand as drought minimisation strategy Paper on the linkage between leaf area and growth
TBA	Phase farming with trees (Kamikaze Project) Ultra-short agroforestry rotations for salinity control (JVAP funded study with UWA,).	Commence field study	06/01 Establish field trials with funding secured from RIRDC 06/01 Write joint paper from scoping study	Publish paper from RIRDC study "Phase Farming With Trees: a scoping study of its potential for salinity control, soil quality enhancement and farm income improvement in dryland agricultural areas of southern Australia."
TBA	Putting Trees in Their Place - optimizing tree placement across the landscape (with Agric WA, UWA, CSIRO Land & Water – NHT-FFP	Establish broadscale planting trials at Wickepin and install measurement equipment Select sites (at least 2) for further broadscale plantings	12/00 Establishment of trials at Wickepin 03/01 Install monitoring equipment 03/01 Selection of 2 further field sites 09/01 Retrospective water use studies in	Establishment of the only broadscale tree planting demonstration and study sites in the MRZ of southern WA that will have both the scale and placement to achieve control of

	funded)	Establish retrospective water use studies in pine and oil mallee plantings on at least 3 sites	pine and oil mallee plantings	recharge at a landscape scale (as per NHT-FFP JVAP project output). These sites will be adequately monitored so that temporal changes can be measured
93/0123	Site evaluation for *E. globulus*	Complete manuscript	06/01 Complete manuscript	Published paper on climatic and soil constraints to the performance of E. globulus across southern WA
93/0138	Performance of *E. globulus* on the Esperance sandplain	Complete manuscript	06/01 Complete manuscript	Published paper on the performance of E. globulus on the Esperance sandplain
TBA	Subsoil constraints to tree water use by *E. globulus* (LWRRDC)	Data analysis for Brinsdens & Rocky Gully (Soil profile, soil moisture, tree water potentials, leaf area, growth, sap flow, hydrogen/deuterium isotope ratios,)	03/02 Collate and calculate HPV data 03/02 MS Examples of soil and climatic conditions and their effects on *Eucalyptus globulus* prepared. 6/02 Convert sapflow data to stand basis, liaise with other authors to update soil moisture calculations 9/02 Write MS's Water relations and growth, 12/02 MS on Soil profiles and water availability	Three papers on the effect of soil and environmental factors on the water use and growth of *E. globulus* in southern WA. Co-authorship with A/Prof. Keith Smettem, UWA.
TBA	Effect of plantation and tree crop establishment on soil carbon contents	Project funded by the CRC Greenhouse Accounting in collaboration with CRC GA Establish field cultivation trials at Wickepin and sample Comparison of soil carbon under trees and adjacent pasture	06/01 Field trials established and measured. 06/01 Field sampling of paired plots completed	Paper effects of plantation establishment on soil carbon contents
93/0128	Early/mid rotation nutrition of *E. globulus* in south west WA	Analyse data Write paper Provide technical information to plantation managers	6/01 Complete data analysis 12/01 Write paper 12/01 Update technical information for plantation managers	Published paper on the nutritional limitations to growth across the environmental range of southern WA
96/0003	Diagnosis and correction of manganese deficiency in *E. globulus* growing on the Esperance sand plain	Analyse data Prepare an internal report	06/01 Complete data analysis 12/01 Prepare an internal report	Report on manganese deficiency supplied to plantation managers.
TBA	Late first rotation and second rotation *E. globulus* growth	Project on hold pending availability of funding from blue	N/A	N/A

Comment [JM1]: Margaret, I think it may be useful to leave this here as a 'draft' project, we got within an ace of having the trials up and running and it was delayed as a result of the negotiations between FPC and overseas investors about the future management of plantations

	and survival	gum investment companies		
93/0130	Drought deaths in *E. globulus* on the Darling Scarp	Complete report and publish	06/01 Report published	Published report on factors influencing drought in *E. globulus*
TBA	Growth, drought tolerance and mortality in *E. globulus* subspecies *bicostata*, *globulus*, *maidenii* and *pseudoglobulus*.	Continue the assessment of the drought tolerance of (*E. globulus subsp. globulus, pseudoglobulus, maidenii and bicostata*, at three sites across WA (Yornup, Kojonup and Esperance)	06/01 Age 4 measurements of trials	Report on subspecies x climate interactions for: growth rate form and wood quality gas exchange root depth competition and drought survival theory
99/008	Productivity and Drought Risk to *Eucalyptus globulus* in the Mediterranean climate of South-Western Australia	Measurements of growth, water deficits, soil moisture depletion, leaf area index and weather continuing monthly Commence modeling of water use and growth data Investigate mechanisms for extending project	06/01 Complete field measurements 06/01 Provide data to CSIRO modellers 06/01 Finalise FPC position re funding	Report to funding organisations Minimum of 3 journal publications on findings from the project relating to the potential growth and water use by blue gum in WA
93/0121	Early rotation nutrition of *P. radiata* on the south coast of WA	Analyse data Prepare 2 manuscripts	12/01 Complete Analyse data 12/02 Prepare 2 manuscripts	*Two papers on early rotation nutrition* of P. radiata *on farmland* Revised management prescriptions for nutrient management on the south coast
93/0122	Diagnosis of nutrient deficiencies in young *P. radiata* using foliar analysis	*Complete 2 manuscripts*	6/01 Complete and submit 2 manuscripts	*Publish two papers on the use of foliar analysis in* P. radiata Change management prescriptions for use of foliar analysis
93/0140	Mid rotation response to thinning and fertilization by *P. radiata* and *P. pinaster*.	Complete 3 draft manuscripts Prepare 2 further manuscripts Continue monitoring existing long-term experiments. Conduct large stem analysis and biomass sampling to conclude field measurements of one experiment	6/01 Complete and submit 2 manuscripts 3/02 Prepare 2 further manuscripts	5 Papers on the silvicultural and water management of plantation sin the high rainfall zone, Revised silvicultural guidelines for the management of these plantations
97/0004	Early rotation silviculture for second rotation pines on the Swan Coastal Plain.	Analyse data Prepare draft manuscripts	06/01 Complete preliminary data analysis 12/01 Draft reports on form problems in *P. pinaster*	Report to Plantation managers on the early rotation management of plantations on the Swan coastal plain
TBA	Comparative use of mineral fertilizers and biosolids on	Continue growth and nutrient measurements	06/01 Continue growth and nutrient measurements	Report to Water Corporation on the efficacy of boisolids as a

	the nutrition of pines on the coastal sand plain.	Preliminary data analysis for report to Water Corporation	12/01 Final data analysis for report to Water Corporation	fertilizer alternative Report on the assessment of the likely risk of contamination of the local groundwater resources from using such material in pine plantations.
Tropical Plantations				
TBA	*Santalum album* : host relations. Plantation growth and heartwood development of the root hemi-parasite *Santalum album* (Indian sandalwood).	Establish multispecies trial on Cununurra clay and cockatoo sands. Establish host:parasite trial on Cununurra clay and Cockatoo sands and in Karnataka, India. Establish progeny trial on Cununurra clay and sand sites in ORIA and Karnataka, India. Conduct growth and yield study on FWI S.album resource and Indian resource jointly with IWST in India. Establish with IWST staff, JFM PROJECT IN India to include sandal.	01/01: propagate sandal and host species for host:para trial. 03/01Collate FWI growth data. 03/01Secure sand sites for multi species and progeny trial. 06/01: Assess host:para (and then every 6 months). Oil yield assessment, FWI. 09/01: Plant host: parasite trial 12/01: Growth and oil yield assessment, India (Sep-Nov) 10/01: Complete host: parasite trial survival assessment and replant if necessary. 12/01 Propagate sandal and hosts for multi species trial and progeny trial. 01/02: Collate growth and oil yield data 06/02: Plant multi species trial and progeny trial	Press article on ACIAR project when finalised Assist with Australian SW seminar Press article – seminar Publish 2 papers on intermediate hosts and soil nutrients Management report re: intermediate hosts Publish progeny trial data Publish HVTS & HVTC papers Report on oil yield and growth data from FWI and India Host international sandal seminar

Outcomes:

Genetic Resources and Tree Breeding

- Increased productivity of commercial farm forestry and plantation species through selection and breeding of superior germplasm and efficient management of breeding programs.
- Efficient domestication programs and development of conservation strategies for native species being developed for farm forestry.
- Rehabilitation of dieback affected forest sites with dieback resistant jarrah seed. .

Tree Crop Management

- Broad scale planting of tree crops in the agricultural area of WA, based on improved prescriptions for establishment and management of trees planted on farmland.
- Increased planting of sandalwood for commercial use in the Wheatbelt.
- Sustainable and profitable plantations (blue-gums, pines) in the wetter areas of the state based on improved prescriptions for establishment and subsequent management.

Tropical Plantations

- Development of a robust tropical forestry program for northern Western Australia based on a practical S. album silvicultural system.
- Increased productivity of S. album and other host species through the selection of improved host and sandalwood genotypes.

Adoption strategy

Genetic Resources and Tree Breeding

- Direct transfer of research results and breeding material to Tree Crop Development Program for incorporation into development strategies for native species.
- Information passed to the public through the Tree Crop Development Program extension group.
- Continuous interaction between Science Division and Plantation Operations Division (FPC) staff on all matters pertaining to tree breeding, species selection and genetic resources to ensure a coherent approach to genetic improvement of tree species in Western Australia.
- Regular meetings with Tree Breeding and Deployment Section of Plantations Operations Division (FPC) to ensure technology transfer and immediate implementation of research results and best breeding material for operational use.
- Transfer of research results to CALM operational staff through reports and workshops.
- Publication of research results in scientific papers in journals and at conferences.

Tree Crop Management

- Preparation and distribution of management prescriptions (via CALM/Agric WA Farm Forestry Advisory Service Tree Note)
- Management reports elaborating on findings
- Field days/seminars for managers with results, training (if necessary) and feedback
- Scientific papers (journals and conference) to put results in the public arena
- Popular press articles
- Information on CALM's Internet site
- Continual advice to plantation managers on informal basis
- Manuals covering the diagnosis and correction of nutrient deficiencies (currently the plantation silviculture manuals are being upgraded)

Tropical Plantations

- Anticipated users of knowledge gained will be FPC Plantations Operations Division, private sector sandalwood investors and regional landowners. The information gained from the research project will be transferred to the major sandalwood growers in the region by one on one interactions and through workshops and field days, and by making the information available to CALM regional staff and FPC officers. Specific information will be disseminated by:
- Management reports to elaborate on findings
- Field days/seminars for private growers (large and small scale, Indigenous communities)
- Scientific papers (journals and conference) to put results in the public arena
- Popular press articles
- Information on CALM's Internet site

Collaborations

Where appropriate and as the opportunities arise we will develop a co-operative Western Australian approach to farm forestry R&D, developing joint funding proposals to prospective sources with partners from other institutions (e.g. Universities, Agric WA, CSIRO). Examples of current collaborations in this area are:

- Examining the ecophysiology of maritime pine and blue gum with UWA and CSIRO respectively.
- Optimising placement of trees in the landscape for enhanced water use and salinity control (NHT Farm Forestry Program, CRC Plant Based Management of Salinity; UWA, AgWA and CSIRO partners)
- Development of an "Australian Site Selection Manual for Farm Forestry" (JVAP funded, CSIRO and UWA partners).
- Developing phase farming with trees as a new land use system to control salinity (RIRDC funded, UWA and CSIRO Land and Water partners)
- Optimising methods of accounting carbon in plantations and soils (CRC Greenhouse Accounting)

In addition where there are mutual benefits, collaborative projects will be developed between CALM and overseas research or management agencies.

Staff

Staff	**Location**	**FTE**
I. Dumbrell	Busselton	1.0
K. Mungham	Busselton	1.0
B. Read	Busselton	0.4
Vacant (Reilly)	Busselton	1.0
Vacant (Hornum)	Dwellingup	1.0
M Byrne	Herbarium	0.5

B.Maslin	Herbarium	0.2
L. Broadhurst	Herbarium	1.0
B. Macdonald	Herbarium	0.5
J. Brand	Kensington	0.5
Vacant (Crombie)	Kensington	1.0
R Harper	Kensington	1.0
R Mazanec	Kensington	1.0
J. McGrath	Kensington	0.2
P.Ritson	Kensington	1.0
M Stukely	Kensington	1.0
B Brand	Kensington	1.0
S. McArthur	Kensington	1.0
S Sochacki	Kensington	1.0
L. Wong	Kensington	1.0
T.Vernes	Kununurra	1.0
M Mason	Manjimup	1.0
C Vellios	Manjimup	1.0
Total		19.3

Program 3: Tree crop Development

Output Purchasers **Nature Conservation Division**
Forest Products Commission
Oil Mallee Company

Program Leader **John Bartle, Kensington**

Program description and objectives:
Description
Development of New Tree Crops
New tree crop development involves pioneering work in taxonomy and genetics, production and processing systems, products and markets, all in the context of creating new industries. It includes selection of priority development areas, pre-feasibility investigation, exploring and developing the technical, environmental and commercial potential of new prospects, business and industry planning and instigating new industries. It currently consists of two main projects.

The oil mallee industry development project commenced in the early 1990s. It undertakes or pro-actively inducts all necessary technical aspects to further the development of a large scale industry based on mallee eucalypts grown in the wheatbelt of WA. The emerging industry has now developed its own commercial structure under the control of growers. CALM has a unique position of leadership in technical and environmental aspects for the industry and is its major technical services provider. CALM has a seat on the Board of the Oil Mallee Company (OMC). The industry has a rapidly increasing planting program, currently 5 million seedlings/year costing $4 million. A commercial feasibility investigation has shown that integrated processing appears to be viable through the concurrent production of eucalyptus oil, higher value wood products from the wood fraction of mallee (initially activated carbon) and bioenergy use of the residues and process heat. A demonstration scale integrated mallee processing plant is to be built at Narrogin during 2001 at a cost of $5 million. The potential for the emergence of a major new industry appears strong.

The oil mallee project has demonstrated the potential of the concept of very short rotation (harvest cycle of 2 to 5 years) tree crops for the wheatbelt. These crops could come in two forms, spouter species like mallee that regenerate by coppice after harvest, and species that regenerate from seed. The coppice species are well suited to permanent belt planting on farmland. The seeders could be used as an alternate phase in conventional annual crop rotations. Some 30 mallee species are currently under development as coppicing crops. Also there has been some initial work on bluegum as a phase crop. There is enormous scope to diversify the range of short rotation tree crops. The native flora is particularly rich in potential species, in particular the genera *Melaleuca* and *Acacia*. This has given rise to the Search project that will objectively select species from the native flora with desirable biological and commercial attributes, and will then initiate commercial development.
Adoption of Tree Crops

This program aims to increase the adoption of existing tree crops, i.e. to get proven commercial tree

crops into mainstream agricultural practice. The adoption program follows a period of some 15 years of R&D during which time several tree crops were evaluated for their potential for integration in agricultural systems. The tree crops evaluated were pine for softwood, bluegum for pulpwood and selected eucalypts for high-grade timber. Systems for integrating these crops into farming practices were tested, costs of production and yields of wood were determined. This work has now advanced to the stage where the most pressing priority is to apply this knowledge. The program does this by stimulating interest, improving understanding and coordinating the activity of the grass roots growers, the wider community and investors.

CALM commenced R&D on eucalypts for high-grade timber in 1981. The goal was to produce high-grade logs within a 20 year rotation, even in medium rainfall zone. Wide-spaced silviculture and pruning have been used. Trials show that it is feasible to produce sawlogs within 20 years from several eucalypt species including *E. globulus*, *E saligna* and *C. maculata*. The timber is suitable for furniture, flooring and other high value uses. These results show that this should be a commercially viable tree crop option for farmers and that there is potential to build a new industry.

Maritime pine industry adoption will expand in proportion to farmer and farm advisor confidence and understanding of the industry. This project will develop and test farm/catchment planning and design options, specifically to make maritime pine attractive to the full range of farmers. It will test and apply a range of technical approaches including interpretation of latest R&D, a planning and design capability based on sound biophysical and economic knowledge of agriculture, forestry and the environment, and finally the skills of agricultural extension. The project aims to perform in a development and demonstration mode to build the foundation of familiarity and acceptance that will be essential for large-scale adoption.

There is an urgent need for improved management of private native forest. The group has recently gained funds under the NHT Program to conduct a project in this area. There are some 500,000 ha of private native forest in WA, much of it poorly managed and rapidly degrading. Clearing of such native forest is now effectively prohibited but there is little knowledge amongst farmers about how to manage it sustainably. This project will review the legal, commercial and environmental issues and define guidelines and practices for sustainable management of private native forest, including commercial uses.

Finally the Tree Crop Development Program has had a major role in training and education. It utilises the extensive knowledge and experience of the group to develop, coordinate and consult on a range of training and education programs related especially to integrated farm forestry.

Objectives:
Development of New Tree Crops

- Conduct reconnaissance, clarify the genetic identity and evaluate performance of all prospective oil mallee species, particularly native wheatbelt species.
- Select superior oil mallee germplasm from wild populations, test and improve genetic performance and manage seed production of the six major oil mallee species.
- Evaluate establishment and management options for oil mallee cropping systems.
- Determine yield, carbon sequestration and management parameters for combinations of season and frequency of harvest across the range of species and sites.
- Develop large volume, low cost harvest and handling machinery and systems for oil mallee and other short rotation tree crops.
- Develop new large volume uses for eucalyptus oil.
- Devise an objective selection process by which species with good commercial potential can be systematically identified.
- Create a focus for commercial development of best bet commercial prospects by instigating large scale planting.
- Adoption of Tree Crops
- Increase the adoption of existing tree crops through developing innovative extension programs designed to make tree crops relevant and attractive to every farmer.
- Develop and promote methods of integration of tree crops into farming systems that are convincing to farmers.
- Instigate formation of a eucalypt sawlog industry.
- Improve the standard of farmer management of private native forest in the intermediate and high rainfall zone.
- Improve the standard of training and education in all aspects of tree crops.

Significance and benefits

Development of New Tree Crops

The salinization process in the south-west agricultural area is pervasive and destructive. It severely impacts on all commercial, conservation and social activities along all drainage lines and valleys floors, and has potential to extend its influence over more than 30% of the landscape. Large-scale commercial tree crops are the *sine qua non* of salinity control. The oil mallee project is the first serious attempt to equip wheatbelt agriculture with a crop that is relevant to the scale of the salinity problem, that has the necessary robustness and profitability to be integrated into the system of agriculture, and has the potential to make our biodiversity protection obligations achievable. It is a coordinated whole industry development that combines public investment with farmer enterprise to achieve multiple public good and commercial benefits. The R&D supported by the public investment component is targeted at critical barriers to creating a commercially viable industry.

The Search project aims to build on the oil mallee project by diversifying the multiple benefit tree crop options available to farmers. This will achieve greater biological and economic diversity in the perennial woody plant component of agriculture thus generating more sustainable agriculture and more stable industries.

Adoption of Tree Crops

A eucalypt sawlog industry could complement and greatly expand the potential for tree crop industries in the intermediate rainfall zone (drier than bluegum but wetter than the wheatbelt). It would complement maritime pine by extending over a much greater range of site types. The first phase of industry development for eucalypt sawlogs will concentrate on establishing a resource in water recovery catchments.

The development of a maritime pine industry is a major State Salinity Plan commitment. This project aims to broaden the range of interest and types of practice in the maritime pine industry. The industry has commenced with a plantation focus but to utilise the full potential of this species it must also be adopted by farmers as a fully integrated crop. This will increase the rate of planting and regional commitment to the industry.

There are some 500 000 ha of native forest on farms in the south west. This is commonly in poor condition and degrading rapidly. It is a sadly neglected conservation and commercial resource. Better recognition of its commercial value may help motivate landowners to improve its management and therefore increase its biodiversity protection value as well as generate revenue.

Training and education enables farmers to evaluate tree crop options and better equip themselves to achieve their long term goals. It increases adoption of tree crops and builds recognition of the imperative for sustainable land management systems.

Targets/Expected results

Project Area	**Project Title**	Key Activities	Milestones	**Outputs**
Oil mallee industry developme nt. (*This project is conducted in partner-ship with the Oil Mallee Company as joint purchaser*)	Gerplasm selection, breeding and propagation for the emerging oil mallee industry.	Locate, voucher and collect seed from elite (high oil content) parents in wild. Conduct progeny trials. Establish and manage OPSSOs. Produce seed. Develop clonal propagation Investigate germination inhibition in seedling propagation.	9/01 Specify and collect seed from required number of elite wild trees. 3/01 Determine breeding values and cull P96 progeny trials. 9/01 Collect first seed from P94 and P95 plenissima and lox/lis OPSSO 4/01Commence clonal propagation trials 2/01 Finalise industry breeding plan with Oil Mallee Company 2/01 Complete first round of germination testing.	Meet demand for P02 oil mallee seed using all orchard seed for the 5 major species. Comprehensive industry breeding plan prepared in conjunction with Oil Mallee Company. Report on germination tests on *E. polybractea*, *E. loxophleba* spp *lissophloia* and *E. horistes* from Anne Cochrane
	Planting density	Investigate appropriate planting spacing	2/01 Determine success of P00 trial establishment	Decision on need for further trials in P01.
	Harvest regime and harvest /handling systems	Establish and tend trials to determine the biomass productivity effects of combinations of season and frequency of harvest. Design and develop large volume harvest and handling systems	11/01 complete field work on the Kalannie trial (Dan Wildy PhD Study). 12/01 Complete establishment of a set season x frequency trials across all species x sites 1/01 Raise approx $5 million in capital to complete operational prototype harvester and handling systems. 3/01 Finalise harvester development plan.	Progress Report to RIRDC 11/01. Progress Report to FFP 11/01. Report detailing development plan for operational prototype harvest and handling systems.
Search project	Demonstration planting	Establish demonstration trials of potential large scale commercial species.	12/00 Evaluate establishment success for P00 plantings and plan P01 activities.	Plan for P01.
	Search process	Develop process to objectively select native species with best commercial potential. Conduct product testing of most prospective products.	3/01 Final selection process draft. 2/01 Plan for prefeasibility investigation of products.	Report for assessment by peers and by the project National Consultative Panel.

	Industry exploration	Commence pre-commercial planting of best prospects, initially melaleuca .	1/01 Get final project approval from NHT.	Detailed project plan
Eucalypt sawlog	Eucalypt Sawlog Industry Development	Coordinate collaborative action between potential participants to create a eucalypt sawlog industry. Monitor growth rates of existing trials on a range of sites in South West. Assist interested landowners to plan, implement & manage eucalypts for sawlogs Conduct farm & industry scale economic analysis	3/01 Develop plans with W&RC & FPC for a pilot planting program in Recovery Catchment. 6/01 Develop an Industry Business Plan 9/01 Trials measured 12/01 Landowners, who are genuinely interested in eucalypts for sawlogs, assisted	100 ha of eucalypts for sawlogs established with landowners in Recovery Catchments Business Plan for a eucalypt sawlog industry produced. Estimates of timber yield for eucalypt sawlog species updated Many new good quality plantings and demonstration sites
Maritime pine	Maritime Pine Industry Development	Work with interested landowners to plan, implement & manage innovative integrated plantings of Maritime pine. Use demonstration plantings to inform local landowners & farm advisors about Maritime pine	3/01 Contribute to field day in Allanooka district on tree crops 6/01 Landowners in Upper Tone and Sth Stirling districts assisted to plan integration of Maritime pine & farming.	Innovative demonstrations plantings Working models and documented planning procedures for integrated planting.
Privately owned native forest	Private Native Forest Project	Undertake an extensive review of all the steps that may be involved in implementing a plan for sustainable management of private native forest in the karri, jarrah and wandoo zones.	3/01 Review social, political, administrative & marketing issues relevant to the management of private native forest. 3/01 Review technical knowledge and experience in managing private native forest. 9/01 Develop a handbook containing guidelines on managing private native forest	Report on social, political, administrative & marketing issues relevant to management of private native forest. Report on technical knowledge and experience in managing private native forest Handbook on containing guidelines on managing private native forest

Training & education	Master Tree Grower Program	Assist State Coordinator to plan and deliver Master Tree Grower Program, primarily for landowners already practicing farm forestry Work with State Coordinator to run follow-up MTG Programs, mainly plot establishment and tree measurement sessions to hone growers skills and to collect local growth data.	3/01 Run Master Tree Grower Program in the Katanning district 9/01 Run Master Tree Grower Program in the Mid-west Region 9/01 Remeasure 20 plots established during 2000 with participating Master Tree Growers	Two courses completed and documented. New tree growth data collection project in place. New grower networks established.
	Farm Forestry Courses and Industry Extension	Assist State Coordinator to plan and deliver Introductory Course in Farm Forestry for farm advisers & workers. Support Better Business in running short Introductory Courses in Farm Forestry for landowners Support key field days and seminars on farm forestry Assist in planning Agroforestry Expo 2002, Mt Barker	3/01 Run Introductory Course in Farm Forestry in Narrogin/ Northam region. 3/01 Short Intro Courses in Farm Forestry run at Albany, Wagin, Harvey, Northam, Gingin and Dandaragan. 3 to 12/01 Participate at and provide input to key field days and seminars. 9/02 Agroforestry Expo 2002, Mt Barker.	Approx 20 farm advisors complete Introductory Course and connect to farm forestry networks, information and services New grower networks established Investment in and adoption of farm forestry increased.

Outcomes

Development of New Tree Crops

- A major new industry based on oil mallee crops available to all wheatbelt farmers.
- Rapid technical advance improves commercial viability and other benefits thus opening substantial growth potential for the industry
- Biodiversity protection on wheatbelt valley floors becomes feasible.
- Three new best bet species (or groups of species) identified, including at least one spouter suitable for use as a phase crop, and these are inducted into commercial development.
- Every farmer has a range of commercial perennial crop options and the potential to achieve a whole farm water balance that brings sustainability within reach.

Adoption of Tree Crops

- Two major tree crops available to farmers in the woolbelt (650 to 400 mm annual rainfall) i.e. a new eucalypt sawlog industry to complement the maritime pine industry.
- The new timber resource on farmland give rise new regional economic development through processing industries.
- Farmers recognise and use commercial tree crop for difficult sites e.g. deep sandy soils that permit groundwater recharge sites and are unproductive under agriculture.
- Farmers have the knowledge and the options to treat the whole landscape to restore water balance and protect biodiversity.
- Improved biodiversity values of hundreds of thousands of hectares of privately owned native forest.
- Additional income for landowners with native forest.
- Additional resource for high-value uses of native timbers.

- Farmers evaluate their tree crop options and make better decisions on integration of tree crops into farming practice.
- Better recognition of the multiple benefits of tree crops shifts farmer opinion and Landcare policy/programs to deliver stronger support for commercial tree crops.
- Landowners adopt farm forestry for commercial and conservation benefits.

Adoption Strategy

Development of New Tree Crops

- Develop the commercial potential of native species to help build tree crop industries able to achieve multiple benefits including land, water and biodiversity conservation.
- Avoid fragmentation of effort amongst stakeholders to achieve coherent commercial development of new tree crop industries.

Adoption of Tree Crops

- Build a partnership with the Water & Rivers Commission to establish a pilot planting program in recovery catchments.
- Foster a cooperative and coherent approach to industry development. Explore the possibility of developing formal collaborative arrangements to facilitate development of the industry.
- Work with leading landowners and farm advisors to build confidence and understanding in Maritime pine.
- Use innovative new plantings by prominent farmers as demonstration sites
- Set high standards in education and training in farm forestry

Collaboration

Seek the opportunity to collaborate in R&D for mutual benefit with any institution or industry, state or national.

In the case of new and emerging industries, make a primary commitment to the best integrated and most open structured commercial operator in that industry. Conduct this relationship through a Service Provider Agreement.

With established industries it may not be appropriate to channel all commitment through a single commercial operator. In this situation a collaborative structure may be more appropriate. In a 'collaborative' all those with a service to provide or an interest in industry development agree to pool their resources and support investment in that industry for a fee. Such fees can generate revenue to finance the management of the collaborative and to finance further R&D. Science Division is in a unique position to lead development of such collaboration.

Staff:

Staff	**Location**	**FTE**
Oil mallee industry development		
John Bartle	Como	1.0
Gary Brennan	Bunbury	1.0
Wally Edgecombe	Como	1.0
Rick Giles	Dwellingup	1.0
Pat Ryan	Geraldton	1.0
Andrew McCarthy	Como	1.0
Don Cooper	Como	1.0
Jerome Carslake	Como	1.0
Adoption of Tree Crops		
Richard Moore	Busselton	1.0
Bob Hingston	Busselton	1.0
Michael Power	Albany	1.0
Glenn Batty	Chowerup	1.0
Dan Huxtable	Kensington	1.0
Total		**13.0**