Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT

Conserving the nature of WA

OPERATIONS PLAN

July 2002 – June 2003

Science Division

Discovering the nature of WA

http://www.naturebase.net/science/science.html

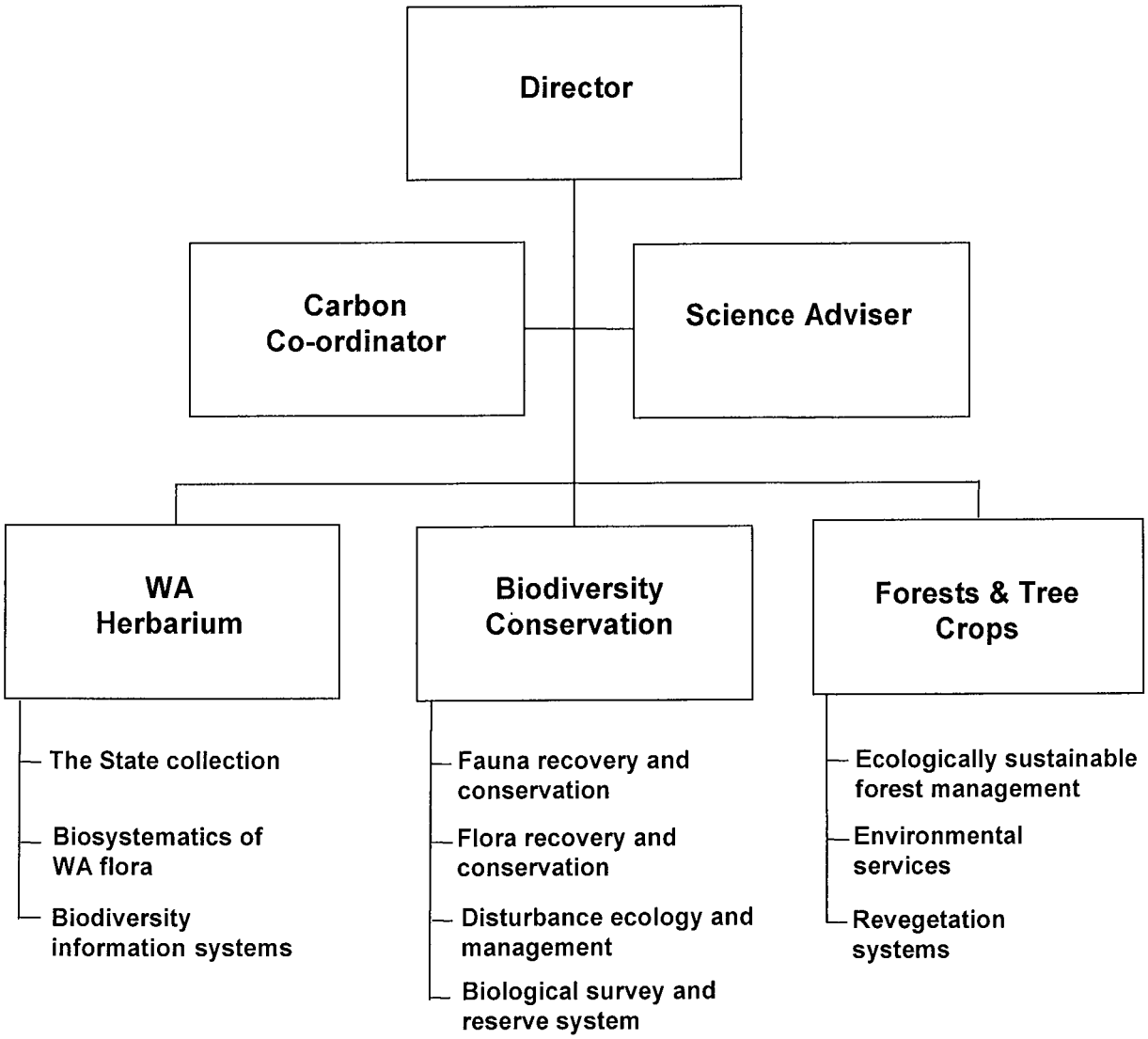
CONTENTS

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 DCLM, 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 (CRC) for Greenhouse Accounting, CRC for Plant-Based Management of Dryland Salinity, CRC for Tropical Savannas, CRC for Pest Animal Control, CRC for Marsupial Management, CRC for BushfireS, CRC for Desert Knowledge, environmental consultants, Forest and Wood Products Research and Development Corporation, Land and Water Australia, Natural Heritage Trust, privately operated sanctuaries, Rural Industries Research and Development Corporation, and Western Australian Police Service.

The Science Division's conservation and land management research activities are structured around three Key Science Themes, or Groups. A separate Operations Plan exists for the Perth Observatory, which is also administered within the Science Division.

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 Groups are delivered effectively, efficiently and at a high standard to end users, and for ensuring that relevant scientific expertise is integrated and co-ordinated 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 Co-ordinator is responsible for the development and implementation of policy relating to carbon sequestration and Greenhouse issues.

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 DCLM Regional and District offices at Dwellingup, Busselton, Albany, Karratha and Kununurra. Collocated at the Research Centre at Kensington is the 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 (DCLM) 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 Plan (WASPP) database on the Science Division website.

Science Division will deliver services to the DCLM 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 July 2002 – June 2003 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.

THE WESTERN AUSTRALIAN HERBARIUM

KEY SCIENCE THEME
Description and documentation of Western Australia's botanical diversity.
Western Australia has a very rich flora 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 flora.

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 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 Division
- Parks and Visitor Services Division

Program 1 The State Collection

Program Leader Chang Sha Fang
Output Purchasers Nature Conservation Division, Parks & Visitor Services Division

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 organizations. 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 unauthorized 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 local parataxonomists 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 DCLM corporate knowledge of native flora and weed species of the State.
- Empower local groups of parataxonomists to be custodians of knowledge of their own regional plants through skills training and education.
- Provide services to the Executive Director, DCLM, 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 DCLM.
- 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 the on-line information systems promote greater awareness and appreciation of the WA flora by the community. They provide an essential service to DCLM staff and external consultants working in the area of conservation and land management, and increase the availability of tourism information to individual providers and local authorities. These benefits are extended by the Regional Herbaria Network, fostering and further developing local knowledge of the State's flora and of conservation issues amongst a wide range of community-based organizations. These include groups concerned with salinity action, Landcare, catchment management, and District Land Management Councils. Vvolunteers, with local expertise, work for the Regional Herbaria and WIN Projects. DCLM and the wider community thus have access to a pool of enthusiastic and trained regional parataxonomists. The Weeds Information Network (WIN) is concerned with documentation of the distribution and biology of weeds, with significant potential benefits to conservation and agriculture. Both the Regional Herbaria and WIN Projects add significant numbers of very well documented specimens to the State Collection and are currently the main source of new herbarium material. The gradually expanding herbarium collection increasingly underpins both government and community initiatives in dealing with major conservation and agricultural problems.

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

Targets/Results Expected

- Attain a total holding of 560 000 vascular plant specimens (c. 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 unauthorized access.
- Provide adequate and safe storage where shelving holds no more than 750 g of specimen and paper material per linear metre.
- Process appropriate specimens from the current backlog of an estimated 70 000 specimens.
- Add 100 specimens to the Reference Herbarium Collection to reflect variation of species.

- Add 5 000 named and well-annotated specimens to the collection.
- Secure representative collection of voucher specimens from DCLM 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 3 new parataxonomists to staff the volunteer identification unit at the WA Herbarium.

Tasks / Activities – Core functions

Core Function	Key Activities	Milestones	Outputs
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 DCLM 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.	**09/02** • Database & incorporate 850 new specimens. • Add 15 specimens to Reference herbarium to reflect morphological variation. • Validate label data & geocodes on 500 specimens. • Add 75 new insertions and 40 edits to nomenclatural database. **12/02** • Database and incorporate 850 new specimens. • Add 15 specimens to Reference herbarium to reflect morphological variation. • Validate label data and geocodes on 500 specimens. • Add 75 new insertions and 40 edits to nomenclatural database. • Secure the State collection from fire, insect attack and unauthorized access. **03/03** • Database and incorporate 850 new specimens. • Add 15 specimens to Reference Herbarium to reflect morphological variation. • Validate label data and geocodes on 500 specimens. • Add 75 new insertions & 40 edits to nomenclatural database. **06/03** • Database and incorporate 850 new specimens. • Add 15 specimens to Reference herbarium to reflect morphological variation. • Validate label data and geocodes on 500 specimens. • Add 75 new insertions and 40 edits to nomenclatural database.	• Historic type specimens from 5 genera housed in WA. • Improved adequacy and representativeness of the State Collection. • Accessible flora information to support conservation research and management. • Support system of well-trained, enthusiastic DCLM volunteers.
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.	**09/02** • 125 specimens added to collection. • 3 conservation taxon populations located and vouchered. • 1 training workshop held	• Specimens added to the Collections. • Regional herbaria activity. • 4 training sessions held. • 12 conservation taxon populations located and vouchered.

	• Communicate effectively with Regional Herbaria and key stakeholder groups. • Provide an efficient identification service for collaborating groups. • Scale down project commensurate with available funding.	• Ongoing ('bridging') funding obtained for Regional Herbaria Network Project. **12/02** • 125 specimens added to collection. • 3 conservation taxon populations located and vouchered. • 1 training workshop held. **03/03** • 20 identifications completed. **06/03** • 100 identifications. • 100 specimens added to collection.	
1.3 Weed Information Network	• Initiation of network parallel with Regional Herbaria Network Project. • Determination of an 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.	**09/02** • 20 detailed species descriptions compiled. **12/02** • 20 detailed species descriptions completed. **03/03** • 20 detailed species descriptions completed. **06/03** • 20 detailed species descriptions completed.	• Weed Information network established with key stakeholders. • Workshops held • Detailed Weed descriptions completed. • Online information retrieval and weed identification system available (via FloraBase).
1.4 Bioprospecting	• Provide services to the DCLM BioProspect Ltd agreement. • Manage the Extract Library • Collect material to service the Agreement.	**09/02** • 100 samples supplied. **12/02** • 100 samples supplied. **03/03** • 20 samples supplied. **06/03** • 50 samples supplied.	• Samples collected and specimens added to the herbarium collection. • 100 vouchered images captured for inclusion in FloraBase.

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 Herbaria Network Project.
- The number of regional based volunteer collectors.
- The number of weed 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 DCLM volunteers at the WA Herbarium.
- Opportunity for DCLM staff to join with informed and trained members of the community (Regional Herbaria Network parataxonomists to learn how to access WA flora information.
- Meeting of obligations under the DCLM-BioProspecting Ltd. bioprospecting agreement.
- Creation of an internationally recognized 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 customized 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 DCLM 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 organizations:

- 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.

Staff

Name	Position	Location	FTE
N Marchant	Group Manager	Kensington, Herbarium	0.2
C S Fang	Collections Manager	Kensington, Herbarium	0.8
Vacancy ex J Wheeler	Senior Research Scientist	Kensington, Herbarium	0.1
R Cranfield	Senior Technical Officer	Manjimup	0.1
K Knight	Technical Officer	Kensington, Herbarium	0.7
C Parker	Technical Officer	Kensington, Herbarium	0.5
P Spencer	Technical Officer	Kensington, Herbarium	0.5
S Carroll	Database Manager	Kensington, Herbarium	0.4
K Veryard	Technical Officer	Kensington, Herbarium	1.0
M Falconer	Technical Officer	Kensington, Herbarium	1.0
M Hislop	Technical Officer	Kensington, Herbarium	0.8
R Davis	Technical Officer	Kensington, Herbarium	1.0
B S Mahon	Librarian	Kensington, Herbarium	0.1
Total			**7.2**

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.'* 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 synthesizes 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, 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.

Inventory; the Census
The Vascular Plant Census is kept up-to-date and entries are verifiable through specimens or published articles, and changes are only made after critical assessment, which requires sound knowledge of the International Code of Botanical Nomenclature. Significant staff resource is allocated to the scientific evaluation 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 recognized). 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 also provide information about organisms for publications and reports. Descriptions are prepared for scientific articles, flora treatments 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 organized 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. The results of taxonomic studies on WA flora are delivered by FloraBase, an activity maintained by Program 3, Biodiversity Information Systems.

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 Program 1, The State Collection, which has the responsibility for curation and maintenance of the collections.

Objectives
The Program seeks to use the best possible practices to:

- Provide an overview of biodiversity in WA by means of a comprehensive inventory through 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 reliably identify them 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.
- The Program provides a uniquely verifiable, authoritative and maintained resource as it is based on the major physical collections of WA plants and associated library, databases and staff expertise and research. This enables conservation scientists and managers to communicate effectively and unambiguously about plants. In addition, 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 utilize DNA and other technologies.
- Publish results of taxonomic studies in scientific journals and in the descriptive component of FloraBase.

Tasks / Activities

Taxonomic tasks involving rare and endangered taxa are given the highest priority. Other conservation species are given a lower but nevertheless high priority for resolution. The bulk of taxonomic work undertaken requires the study of all taxa in a family, genus, subgenus or species complex only a small proportion of which are so-called conservation taxa.

The effort required to address taxonomic problems varies from minutes to days. Long-term revisionary studies are no longer being pursued because of lack of resources and the need to cover a range of taxonomic problem solving in short time frames.

Core Function	Key Activities	Milestones	Output
2.1.1 Taxonomic studies of species on the Declared Rare and Priority Flora List	• 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.	**09/02** • 8 taxonomic problems resolved. **12/02** • 8 taxonomic problems resolved. **03/03** • 8 taxonomic problems resolved. **06/03** • 8 taxonomic problems resolved. • Declared Rare and Priority Flora List updated.	• Resolution of taxonomic problems. • Up-to-date Declared Rare and Priority Flora list.
2.1.2 Taxonomic studies of Conservation Priority species	As above	**09/02** • 5 taxonomic problems resolved. **12/02** • Update Priority list for NCD Wildlife Branch on taxa	• Publications. • Up-to-date Priority Flora List.

		with conservation status. **03/03** • Determine list of taxa in need of taxonomic study. **06/03** • Second Priority list update to NCD Wildlife Branch	
2.1.3 Taxonomic studies in the family Asteraceae	• Revisionary studies of *Olearia*. • Systematic studies of tribe Astereae. • Porting of DELTA data sets to FloraBase.	**09/02** • Commence paper describing new species of *Olearia*. **12/02** • Continue paper describing new species of *Olearia*. **03/03** • Complete paper describing new species of *Olearia*. • Finalize DELTA coded Astereaceae genera of WA data set. • Finalize paper on *Erodiophyllum*. **06/03** • Finalize paper describing new WA genus, *Pilbara*. • WA *Olearia, Erodiophyllum, & Pilbara* data ported to FloraBase.	• Publication of 3 papers describing ca 20 new species of Astereaceae. • WAGenera DELTA data set for Asteraceae genera.
2.1.4 Taxonomic studies in the family Poaceae	• Revisionary studies of critical groups of *Amphipogon*, Stipeae, *Haemodorum, Urodon, Neurachne* & *Austrodanthonia*. • Porting of DELTA data sets to FloraBase.	**09/02** • Revision of *Amphipogon* paper completed. **12/02** • Revision of Stipeae paper completed. **03/03** • *Stipeae, Amphipogon* DELTA data sets placed appropriately in FloraBase with interactive key. **06/03** • Paper on a new species of *Austrodanthonia* completed.	• 4 publications completed.
2.1.5 Taxonomic studies in the Epacridaceae	• Revisionary studies of the genus *Leucopogon*. • Systematic studies of tribe Styphelieae. • Floristic studies in the family Epacridaceae.	**09/02** • Current descriptive data for *Leucopogon* converted to DELTA Editor format. • Paper describing the new WA species *Monotoca aristata* completed. **12/02** • Report on epacrid conservation taxa and their current status revised. • DELTA dataset integrated with WA Herbarium core characters. • Development of an online specimen and nomenclatural database system for Epacridaceae species commenced. **03/03** • Online specimen and nomenclatural database system loaded with nomenclatural information for Epacridaceae and type information for *Leucopogon*.	• 2 papers describing new species of Epacridaceae. • Report into conservation status of Epacridaceae species. • Online Epacrid database. • Publication of Western Australian *Leucopogon* DELTA data set.

		• Application for ABRS funding for Epacridaceae for the Flora of Australia. **06/03** • Online specimen and nomenclatural database system updated with *Leucopogon* descriptions. • Epacridaceae web interface demonstrated to national collaborators. • Specialist curation of WA Herbarium specimens of *Leucopogon* complete. • Type material of WA *Leucopogon* species examined and annotated. • Paper describing new species of *Leucopogon* prepared. • Current WA *Leucopogon* descriptive data incorporated into FloraBase.	
2.1.6 Taxonomic studies in the Myrtaceae	• Revisionary studies of *Baeckea s. lat.* and related genera (including *Thryptomene*) of the Myrtaceae. • Update of the lists of conservation priority taxa of Baeckea and Thryptomene. • Revisionary studies of the *Agonis* complex and its segregate genera. • Revisionary and morphological studies of *Actinodium.* • Revisionary studies of *Chamelaucium.* • Revisionary studies of *Darwinia.*	**09/02** • Paper describing the new genus *Enekbatus* published. • Complete study on *Chamelaucium.* **12/02** • Continue Investigation of the generic limits of *Thryptomene* and its allies. • Complete study on *Actinodium.* • Capture DELTA data for *Chamelaucium.* **03/03** • Paper on *Thryptomene* sect. *Astraea* published. **06/03** • Publish Taxonomic revision of *Agonis* and its segregate genera. • Publish paper on *Actinodium.*	• Two papers on the Myrtaceae, one describing a new genus of 6 species and the other a section with over 20 species. • Publication of 3 papers on *Agonis* and its allies in WA. • Update of specimen holdings and FloraBase entries of all genera and species studied.
2.1.7 Taxonomic studies in the Dilleniaceae	• Revisionary studies in *Hibbertia.* • Publication of new taxa. • Update of list of rare and endangered, and Priority taxa.	**09/02** • Preparation of descriptions of 5 new taxa. **12/02** • Publication of 5 new *Hibbertia* taxa. • Updating of herbarium curation of 50 species of *Hibbertia.*	• Clarification of the species of *Hibbertia*, published account and identification of WA taxa of *Hibbertia.* • *Hibbertia* information available in FloraBase.
2.1.8 Flora of the South West	• Publication of keys, illustrations and descriptions of the flora of the Bunbury, Augusta Margaret River area.	**09/02** • 2-volume book published and launched.	• User-friendly guide to the vascular flora of the SW forest regions published.
2.2 Weed taxonomy, biosecurity assessment and incursion monitoring	• Correct names applied to weeds of State significance. • Development of an electronic flora of alien invasive species. • Databasing of biological information (biosecurity assessment.)	**09/02** • 50 weed descriptions coded. • 10 alien taxon names confirmed. **12/02** • 20 weed descriptions coded by volunteers. **03/03**	• 100 comprehensive species descriptions available in FloraBase. • Authoritative list of weed taxa published and available electronically.

		• 10 weed descriptions coded (cessation of funding). • Names of all weed collections of legumes confirmed. **06/03** • Project scaled down, almost wholly dependent on volunteers.	
2.3 Managing The Herbarium's taxonomic journal *Nuytsia*	• Facilitating the formal publication of names of WA plant species and information for identifying and characterising them.	**09/02** • Edit papers. **12/02** • Publish Volume 15 part 1. **03/03** • Edit papers. **06/03** • Publish Volume 15 part 2.	• Provision of formal names for conservation and non-conservation taxa. • Publication of journal.

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 DCLM staff concerned with the taxonomy of conservation taxa.
- A sound scientific basis for biodiversity inventory, critical to many aspects of DCLM's research and management work.
- Enhanced knowledge and appreciation of the identity, occurrence and properties of native plants amongst DCLM 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 DCLM 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 DCLM 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 Biodiversity 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 DCLM 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 organizations:

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

Staff

Name	Position	Location	FTE/CF
T Macfarlane	Senior Research Scientist	Manjimup	0.9
N Marchant	Group Manager	Kensington, Herbarium	0.2
N Lander	Principal Research Scientist	Kensington, Herbarium	0.2
B Rye	Senior Research Scientist	Kensington, Herbarium	0.5
Vacancy ex J Wheeler	Senior Research Scientist	Kensington, Herbarium	0.9
A Chapman	Research Scientist	Kensington, Herbarium	0.9
R Cranfield	Senior Technical Officer	Manjimup	0.9
M Trudgen	Senior Research Scientist	Kensington, Herbarium	0.4
J Wege	Research Scientist	Kensington, Herbarium	1.0
B S Mahon	Librarian	Kensington, Herbarium	0.3
Total			**6.2**

Program 3 Biodiversity Information Systems

Program Leader 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 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 DCLM 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: -

3.1 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 DCLM staff, consultants, tertiary institutions, school, nurseries and members of the general community. It currently services c. 100 enquiries per hour without cease. It is thus the public face of the WA Herbarium.

3.1.1 WACensus
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 DCLM such as the Wildlife Branch DRF database and the Herbarium 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.

3.1.2 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 DCLM.

3.1.3 E-flora (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.

3.2 NatureMap

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. The system will also display a range of themes based on the outcomes of associated projects and deliver these outputs through GIS applications that will be visible on the intranet and, eventually, the Internet.

3.3 Max

Max is a species-editing program that builds on and takes advantage of WA Herbarium 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.

3.4 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.

3.5 Australia's Virtual Herbarium

Australia's Virtual Herbarium is a co-operative program between all of Australia's major Herbaria to provide a single, web-based portal for querying Herbarium data. The data are presented as if stored in a single, virtual database. This function includes the infrastructure and FTE required to implement and support a local node of the AVH.

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 minimize duplication of effort and optimise information flow.
- Collaborate with scientists on biodiversity analyses based on Herbarium databases.
- Liaise and integrate with other groups within DCLM and appropriate external organizations, to allow for exchange of research findings, ideas, data, software and other products.
- 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 flora of Western Australia to all DCLM 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 Divisional Research Centres. 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

- Extend and update and make readily available the database of label data for more than 0.55 million vascular plant specimens (c. 40 specimens per taxon).
- Identify taxonomic, phenological and geographical gaps in collection (e.g. Pilbara, Collie Basin and wheatbelt) and liaise with Regional Herbaria Network Project to target these areas.
- Identify gross outliers in WAHerb (c. 505 000 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.

Tasks / Activities

Core Function	Tasks / Activities	Milestones	Outputs
3.1 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.	**09/02** • Implementation of new registration system. **12/02** • Addition of generic and family descriptions from the WAGenera project. **03/03** • Addition of illustrated glossary, example Intkey data sets, phylogenetic exploration tool and other components to FloraBase. **06/03** • 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.
3.1.1 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	**09/02** • Addition of lichen family names to census. • Insertion and editing of 100 names in census. **12/02** • Hardcopy of census. • Insertion and editing of 100 names in census. **03/03** • Addition of fungi names to	• Species names support for Herbarium IT systems. • Names distribution to Max clients, FloraBase, DEFL, etc. • Printed / online census. • Hardcopy of census. • Insertion and editing of 400 names in census.

Core Function	Tasks / Activities	Milestones	Outputs
	WACensus system. • Generate periodic hardcopy of Census.	census. • Insertion and editing of 100 names in census. **06/03** • Migration of WACensus to GUI environment. • Insertion and editing of 100 names in census. • Addition of lichen species names to census.	
3.1.2 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 DCLM's NatureBase web site and controlled presentation of specimen data to national and international research associates. • Automated data output for warehousing in NATUREMAP 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.	**09/02** • Initiate GDA compliance through implementing software support. • Insertion of 5 000 records in WAHerb. **12/02** • All outgoing exchange and loan material accompanied by a HISPID 3 compliant data file. • Insertion of 5 000 records in WAHerb. **03/03** • Insertion of 5 000 records in WAHerb. • Final implementation of GDA. **06/03** • Insertion of 5 000 records in WAHerb.	• Corporate database for plant identification, fieldwork and conservation information. • Data source for FloraBase. • Data source for GIS applications. • Servicing of data requests from DCLM staff and external consultants.
3.1.3 DELTA Database Engine (SPP 96/13)	• Review the DELTA descriptive language and associated softwares. • Review DCLM'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 and conversion of existing DELTA projects into the institutional framework. • Provide user education and documentation.	**03/03** • Release Deliah home page. • Release Beta test version of Deliah for Internet access.	• A tool for managing Taxonomic Descriptive Data at the corporate level. • A tool for managing taxonomic and name changes to Descriptive Data. • A tool for generation of FloraBase data and its integration with WAHerb and WACensus. • A tool for management of E-Flora data and its integration into FloraBase. • Capacity for generating exception reports for the Descriptive Data.
3.2 NatureMap	• Solicit funding for SDE and support for GIS FTE. • Web development. • Program development. • Data uptake for species	**09/02** • Update NatureMap interface to include authentication (subject to funding). **03/03**	• Real-time GIS querying capability over the web. • Capacity to answer 'where is what?' and 'what is where?' for flora and fauna from vouchered

Core Function	Tasks / Activities	Milestones	Outputs
	data warehouse. • Development of NatureMap data model.	• Implement development and production SDE servers.	and unvouchered sources. • Hardcopy maps for incorporation in reports. • Species lists for reserves, shires, etc.
3.3 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. • Extend Max to support systematic site surveys.	**03/03** • Implement user-defined fields. **06/03** • Implement site/species forms.	• A tool for managing name changes in species databases. • A collecting book for use by DCLM staff, Regional Herbaria participants and commercial companies.
3.4 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 DCLM's Executive IT Management Committee.	**03/03** • Update Science House and Kensington Research LAN to 100M bit. • Undertake software audit for Herbarium. **06/03** • Provide support for updating Manjimup server.	• Increased reliability of Kensington Research and Science House LAN. • Increased performance of LAN.
3.5 Australia's Virtual Herbarium Project (AVH)	• Identify backlog and database specimens. • Validate geocodes. • Implement and maintain local AVH node. • Implement HISPID data import and export.	**06/03** • 18000 backlog specimens databased. • 400 geocodes validated.	• Specimen backlog databased and validated. • WA Herbarium database visible on all AVH nodes. • Data transfer capability between Australian Herbaria.

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 Herbaria Network Project.
- Number of regional based volunteer collectors.
- Number of weed species correctly named in the database systems.
- 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 DCLM 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 DCLM 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 are effectively managed and productivity is maximized.
- 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 DCLM with a basis for negotiation with industry partners exploiting WA plant species for commercial benefit.
- Improved decision support systems (eg RFA, Salinity Action Plan, DCLM 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 DCLM estate through online systems such as FloraBase.

Adoption/Uptake Strategy

- Liaison with DCLM's Executive IT Management Committee and Information Management Branch to represent Science Division's interests and be appraised of IT implications for the Division.
- Increase liaison between the Herbarium and DCLM staff, the WA Museum, consultants and other contributors / maintainers of WA species data to a) increase awareness of the role of the census as a fundamental dataset underpinning science and conservation efforts within DCLM and the State; b) increase consultation of the WACENSUS database during survey and research projects, and c) increase 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 organizations:

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

Staff

Name	Position	Location	FTE
P Gioia	Senior Research Scientist	Kensington, Herbarium	1.0
N Lander	Senior. Research Scientist	Kensington, Herbarium	0.3
T Macfarlane	Senior Research Scientist	Manjimup	0.1
M Choo	Senior Research Scientist	Kensington, Herbarium	1.0
B Richardson	Senior Technical Officer	Kensington, Herbarium	0.8
A Chapman	Research Scientist	Kensington, Herbarium	0.1
A Spooner	Technical Officer	Kensington, Herbarium	0.3
B S Mahon	Librarian	Kensington, Herbarium	0.2
S Carroll	Database Manager	Kensington, Herbarium	0.6
E McGough	AVH Database	Kensington, Herbarium	0.5
Skye Arkeveld	AVH Database	Kensington, Herbarium	0.7
M Ware	AVH Database	Kensington, Herbarium	0.5
M Hislop	AVH Technical Officer	Kensington, Herbarium	0.2
C Tauss	AVH Technical Officer	Kensington, Herbarium	0.5
Total			**6.8**

BIODIVERSITY CONSERVATION GROUP

KEY SCIENCE THEME

Protection and conservation of Western Australia's biological diversity. Research undertaken in the Biodiversity Conservation Group 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 DCLM's activities, services and policies.
- Be responsive to the community.
- Increase involvement of traditional owners in managing conservation lands and waters.
- Partner with agencies and groups with similar interests.

PURCHASER REQUIRING SERVICE

- Nature Conservation
- Parks and Visitor Services

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 c. 50 % 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 these 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 minimize 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 programs, 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 which are dependent upon their presence (e.g. increased digging of soil by woylie and bandicoots). The program will benefit biological communities immensely, and the human community will also benefit from a new access to Australian animals. Massive educational and ecotourism opportunities will certainly result.

The marine research being undertaken within this program is essential for the acquisition and management of DCLM'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 off-shore areas of Western Australia.

Results Expected

- Increase in knowledge of threatened taxa biology and conservation, 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.
- Continue research into more cost effective 'Pro Bait' fox bait.
- Continue research into the required frequency and intensity of cat baiting.
- Commence research into the interaction of cats and foxes in the south-west of WA.
- Identification and management of other threatening processes.

Performance Indicators

- A reduction in the abundance of foxes and feral cats in conservation estate.
- 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

SPP No.	Project Title	Key Activities	Milestones	Outputs
93/0017	Database of mammal records from Australian islands	Update database as required.	**06/03** Transfer data to NatureMap	Integration of biodiversity databases.
93/0018	Seabird breeding islands database	Update database as required	**06/03** Transfer data to NatureMap	Integration of biodiversity databases.
93/0022	Conservation status of butterflies	Continue field research on threatened species.	**06/03** Prepare SPP on ecology of Western Australian butterflies. Prepare PhD Progress reports.	Progress reports
93/0022	Conservation status of butterflies	Continue field research on threatened species.	**06/03** Prepare SPP on ecology of Western Australian butterflies. Prepare PhD Progress reports.	Progress reports
93/0040	Conservation of marine turtles	Facilitate review of turtle management activities. Finalize management plan. Provide support for Regional turtle monitoring programs. Finalize research into impact of indigenous take of turtles. Maintain and upgrade tagging database.	**03/03** Prepare paper on indigenous take for conference. **06/03** 1. Fully functional database, commence rookery analysis. 2. Complete planning turtle census program. 3. Complete management plan for turtles.	Paper on indigenous take. Publish turtle management plan. Functional database. Summaries of tagging information available.
93/0041	Dugong conservation – NW Australia	Finalize management plan in collaboration with Marine Conservation Branch.	**06/03** Complete management plan for dugongs.	Dugong management plan.
93/0053	Recovery plan for the Chuditch	Complete chapter in the Dasyurid Symposium book. Monitor semi arid sites – cat impacts?	**06/03** Publish chuditch recovery case study.	Book chapter summarizing most of the ecological and management work on Chuditch.
93/0054	Effect of fox control on habitat utilization by the mainland Quokka	Ongoing maintenance of Quokka distribution database linked to GIS. Develop Quokka distribution database that is accessible to DCLM Districts and regions via the DCLM web through a GIS interface in read only format. Develop proposal for habitat manipulation of	Ongoing maintenance of Quokka database. **06/03** 1. Complete paper on diet of the Quokka in the northern jarrah forest. 2. Complete paper on population size of the mainland quokka.	Publication on Quokka diet. Publication on population size.

		Quokka swamps in the northern jarrah forest in conjunction with Fire Biodiversity project.		
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.	Complete annual report to Western swamp tortoise recovery team.	Recovery Team annual reports.
93/0065	Conservation of the Western bristlebird	Monitor translocated population in Walpole – Nornalup NP and assess options for further translocations. Assess response to fire in Fitzgerald River NP. Write report/ publication on the effects of fire on bristlebirds. Write recovery plan	**03/03** Create database of bristlebird location records. **06/03** 1. Continue monitoring of translocated population at Walpole-Nornalup NP. 2. Prepare paper on effects of fire on birds. 3. Draft recovery plan (subject to funding).	Report to Western bristlebird recovery team. Report / publication on effects of fire on bristlebirds. Approved Recovery Plan.
93/0093	Conservation of threatened frogs	Monitor *Geocrinia lutea* sites Oct/Nov each year. Model effects of fire. Prepare report for recovery team	**12/02** Complete report for recovery team.	Recovery team Report.
93/0142	Conservation of the Western ringtail possum	Ongoing maintenance of western ringtail possum distribution database. Continue development of Western ringtail possum distribution database. Continue analysis of data from Yalgorup and Lane Poole translocations. Prepare manuscripts for publication on Leschenault translocation, use of Ketamine and Xylazine, development of dart gun and review of distribution all at advanced draft stage Continue liaison with Western ringtail possum recovery team. Continue research (PhD) on translocation of Western ringtail possum to assess the importance of competition with brushtail possums, effectiveness of 1080 baiting, interactions between predators, prey switching etc, as identified as potential causes for the failure of the Leschenault translocations.	**03/03** Recovery team meetings. **06/03** Drafts of papers on review of distribution & conservation status, translocation of rehabilitated possums, home range and habitat use at jarrah forest translocation release sites, use of Ketamine and Xylazine for immobilization of the western ringtail possum and the brush-tailed bettong, a new tranquiliser dart gun for capture of small to medium sized arboreal marsupials.	Strategy for Western ringtail possum translocations. Advanced drafts of papers.
93/0144	Quenda translocation methods	Complete monitoring program at Dongolocking. Write MS.	**06/03** 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	Continue monitoring radio-collared animals in Stirling Range and Hills Forest	**06/03** 1. Complete annual report to recovery team.	Review paper on Numbat translocations. Report on the conservation status of the

	reintroduction program	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.	2. Deliver presentation to Dryandra Woodland Ecology Course. 3. Draft of Landscope paper.	numbat. Annual report to recovery team. 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.	**06/03** Draft paper on the impact of fox control on *P. calura*.	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	Continue analysis of operation foxglove trapping data, vegetation / habitat data, Brushtail possum den tree use data, and Woylie survivorship data. Revise guidelines for optimal fox baiting regimes in the forest. Prepare guidelines for habitat tree selection Prepare publications.	**03/03** 1. Complete analysis of trapping data, vegetation / habitat, and Brushtail possum den tree use. 2. Complete report on the optimal fox baiting regimes for the northern jarrah forest. 3. Complete report on selection of habitat trees for Brushtail possums. **06/03** 1. Complete paper on survivorship of translocated populations of the Woylie and implications for operational 1080 baiting programs. 2. Complete paper on native fauna response to different levels of fox density reduction.	Revised report on the optimal fox baiting regimes for the northern jarrah forest. Revised report on the selection of habitat trees for Brushtail possums. Publications on survivorship of translocated populations of the Woylie and implications for operational 1080 baiting programs, native fauna response to different levels of fox density reduction.
93/0159	Ecology and conservation of WA pythons	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. Publication of papers on home range, reproduction, activity and thermoregulation data.	**06/03** Draft papers on the home range, reproduction, activity and thermoregulation of Carpet pythons.	MS on home range and activity patterns of pythons. MS on thermoregulation in pythons.
93/0163	Genetics and ecology of the Western barred bandicoot	Through collaborative work determine cause of infection detected in captive breeding colonies and Bernier Island animals.	**06/03** Determine cause of disease in bandicoots.	Recommendations about captive breeding of bandicoots.
95/0005	Conservation strategy for the western desert rock-wallaby	Continue monitoring and fox control at Calvert Range.	**12/02** hand over operational baiting to Pilbara Region. **06/03** Monitor rock-wallabies by trapping and collection	Sustained populations of Rock-wallabies.

			genetic material.	
95/0011	Status and ecology of the Dibbler in WA	Commence survey in Torndirrup NP and Cape Arid NP. Continue monitoring Escape Island translocated population and Boullanger / Whitlock Island populations. Continue survey of south coast. Continue monitoring and ecological research 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 MS on Dibblers in FRNP	**03/03** Complete translocation proposal for a mainland translocation. **06/03** 1. Complete annual report to recovery team. 2. Complete Landscope article on Dibblers. 3. Complete annual report to recovery team.	Annual report to the recovery team. Publication on Dibblers in the FRNP. Landscope article on dibblers.
95/0016	Experimental management and monitoring of Desert rock wallaby populations	Liaison with Ngaanyatjarra Council and DCLM 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 article	**04/03** Monitor population.	Landscope article. Resolution of taxonomic issues.
96/0001	Fox population dynamics	Simulate the impact of fertility control on fox demographics. Write MS.	**03/03** Complete MS 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. Carry out regular trapping of known colonies on Mount Gardner. Continue survey for further populations. Maintain captive colony at TPB. Support development of cross-fostering project Carry out nutrient analysis of hypogeal fungi, to assist in development of captive diet. Write Landscope article. Write MS on home-range of Gilbert's potoroo. Write MS on population dynamics of Gilbert's potoroo.	**06/03** Draft MS on home-range of Gilbert's, and population dynamics of GP.	Manuscripts on the home-range of Gilbert's potoroo and the population dynamics of Gilbert's potoroo.
96/0014	Broadscale cat control – census and baiting	Finalize bait development. Determine optimal baiting frequency and intensity.	**06/03** Draft MS on cat control techniques.	MS on cat control techniques.

	regimes.	Achieve cat bait production Provide protocols for cat control in the arid zone. Write paper on cat control techniques.		
97/0005	Fox and cat density estimates, survivorship, and home range estimates in the presence of 1080 baiting within the Northern Jarrah Forest – 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 jarrah forest. Analyse data. Prepare MS.	**06/03** Draft publications on use and validation of sandplotting to derive an index to fox density, and the use of satellite telemetry to monitor movements of the Red fox.	MS on the use and validation of sandplotting to derive an index to fox density, and the use of satellite telemetry to monitor movements of the Red fox.
98/0005	Status, ecology and conservation of the Pilbara Olive python	Radio-telemetry at Millstream and Burrup and replacement of transmitters. Captive breeding studies at Tom Price. Liaison with community groups.	**06/03** Prepare draft of paper on radio telemetry studies.	Report to NHT on Burrup work. MS for Wildlife Research on radio-telemetric work at Pannawonica.
98/0016	Status of the Pebble-mound mice	Fred Ford, JCU, has completed genetic phylogony and taxonomy of Australian Pebble-mound mice for PhD.	**06/03** Complete manuscript comparing mound structures of Pebble-mound mice species.	Paper comparing mound structure of different pebble mound mice species.
99/0011	Recovery plan implementation for the Lancelin Island skink	Carry out actions listed in published Recovery Plan. Monitor translocated and Lancelin Island populations.	**03/03** Monitor translocated population.	MS on the genetic status of 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.	**06/03** 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	Redo bait uptake trials. Combine results of this SPP with those of SPP 2000/0014 (Probait Phase 2). Write report	See SPP 2000/0014.	See SPP 2000/0014.
00/0002	Ground Parrot recovery	Develop monitoring protocol. Analyse data from monitoring program. Write Recovery Plan – 2003. Implement Recovery Plan where funds permit.	**06/03** Draft Recovery Plan circulated.	Approved Recovery Plan Scientific publication on post-fire monitoring.
00/0014	'Probait' Phase 2.	Determine the field longevity of Probaits. Combine results of this SPP with those of SPP 99/0018 (Probait Phase 1) to produce a report. Write report on the uptake of Probaits by foxes.	**06/03** Complete field trials on Probait longevity.	Report: 'The uptake of Probaits by foxes'.
No SPP	Return to Dryandra	Write SPP. Establish populations of 5 species in 20 ha enclosure in conjunction with Narrogin	**06/03** 1. Prepare for translocation of Boodies to **06/03. 2.**	Report to Western Shield committee. Landscope article. Publication on Bilby reintroduction. Field day

		staff. Carry out regular monitoring of enclosure populations. Continue to monitor reintroduced Bilbies in Dryandra Woodland (outside fence). Carry out translocation of Boodies to Dryandra Woodland (outside fence). Write WS review report. Write Landscope article. Write MS.	Complete report to Western Shield committee. 3. Complete Landscope article. 4. Complete publication on Bilby reintroduction.	involving neighbours and interested persons.
00/0012	Monitoring of Barrow Island mammals	Undertake annual monitoring trip to Barrow Island. Enter trapping and spotlighting data into database. Analyse spotlighting data. Write reports to Chevron Texaco and DCLM with recommendations about future work / requirements.	**10/02** Complete monitoring. **11/02** Complete trapping data entry. Complete analysis of spotlighting data. **12/02** Complete report.	Reports and recommendations to Chevron Texaco and DCLM. Advice on impacts of proposed Gorgon oilfield development.
01/0002	Conservation of Mulgara and other arid zone dasyurids	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.	**06/03** Monitoring of Mt Keith population. **08/03** 1. Radio-telemetry of Mulgaras in breeding season. 2. Complete annual report to Western Mining.	Annual reports to Western Mining Corporation (main source of funds) and the Mulgara Recovery Team.
No SPP	Taxonomy and ecology of the Heath mouse	Undertake habitat assessment. Undertake extensive trapping in Lake Magenta NR.and Fitzgerald River NP. Facilitate PhD project. Seek funding from Ravensthorpe Nickel Operations. Undertake genetic assessment east vs west (Peter Spencer Marsupial CRC). Review conservation status after taxonomy resolved. Assess other sites for heath rats.	**11/02** Select study sites **05/03** Complete analysis of distribution at Lake Magenta NR. **06/03** Commence fledwork at FRNP.	Report on the distribution of the heath rat in WA. Report on the conservation status of heath rats in WA. PhD.

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.

Partners/Collaborators
The following organizations 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 Western Australia – Zoology, Animal Science
- Murdoch University – Veterinary Clinical Science and Biological Sciences
- University of New South Wales
- Perth Zoo
- Pest Animal Control CRC
- Department of Commerce and Trade
- WA Department of Agriculture
- Perth Zoo
- Kanyana Wildlife Rehabilitation Centre
- Alcoa
- Boddington Gold Mine
- Karakamia Sanctuary
- Ravensthorpe Nickel Operations
- Proposed Centre of Excellence

Staff

Staff	Position	Location	FTE
D. Algar	Senior Research Scientist	Woodvale	1.00
A.H. Burbidge	Senior Research Scientist	Woodvale	0.15
P. de Tores	Research Scientist	Woodvale	1.00
T. Friend	Principal Research Scientist	Albany	1.00
N. Marlow	Senior Research Scientist	Woodvale	1.00
K. Morris	Senior Principal Research Scientist	Woodvale	0.20
D. Pearson	Principal Research Scientist	Woodvale	0.75
R. Prince	Senior Research Scientist	Woodvale	1.00
T. Start	Principal Research Scientist	Woodvale	0.10
M. Williams	Research Scientist	Kensington	0.40
Scientist Total			**6.60**
J. Angus	Senior Technical Officer	Woodvale	1.00
B. Johnson	Principal Technical Officer	Woodvale	1.00
M. Onus	Senior Technical Officer	Woodvale	1.00
J. Rolfe	Senior Technical Officer	Woodvale	1.00
N. Thomas	Senior Technical Officer	Woodvale	1.00
A. Williams	Senior Technical Officer	Woodvale	1.00
N. Hamilton	Technical Officer (external)	Woodvale	1.00
Technical Officer Total			**7.00**
Total			**13.6**

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 focuses on the conservation and recovery of the Western Australian flora with particular emphasis on the conservation of rare and threatened flora, and the management of remnant vegetation in fragmented landscapes. The 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 2413 rare and threatened plant taxa in WA, of which 337 are threatened with 120 critically endangered requiring 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.

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 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 10 years. Although this work is largely completed in the south-west as the Districts take over program production and/or updating, 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 1192 flora listed by DCLM as poorly known but considered to be rare and likely to be threatened (Priority 1 and 2, DCLM listing). Probably as a many as 10%, based on current DCLM estimates, are 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 localized 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.

Research on threatened flora is complemented by a population viability analysis approach to the management and conservation of remnant vegetation in fragmented landscapes, particularly the wheatbelt. This work combines molecular genetic and demographic approaches in the quantification of genetic and ecological factors that influence the viability of plant populations and explores how these are affected by remnant characteristics such as size, disturbance and landscape position.

Objectives

- Develop 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 prioritization 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, prioritization and conservation of the Western Australian flora.
- Determine thresholds of population size and landscape context required for genetic and ecological viability of life history classes such as trees, shrubs and herbs in remnant vegetation.
- Identify key biological processes affecting population performance and determine under what remnant vegetation conditions they limit viability and remnant conservation value.

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, and the management of remnant vegetation in fragmented landscapes. 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 prioritization 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 localized control of *Phytophthora* in populations of critically endangered plants, threatened ecological communities and other areas of high conservation value. Guidelines will be developed for the appropriate management of viable vegetation remnants in degraded and fragmented landscapes to ensure the long term persistence of native flora in areas such as the wheatbelt.

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).
- Improved conservation of wheatbelt remnant vegetation.

Performance Indicators

- An increase in the number of taxa downgraded or removed from the State's threatened flora lists.
- Representative *ex situ* germplasm storage of threatened and high priority flora, particularly those nominated through the Salinity Action Plan and Millennium Seed Bank Project.
- Number of critically endangered flora populations successfully established through translocations
- Increase in the area of habitat managed for the control of weeds and phosphite control of *Phytophthora.*

Tasks / Activities

SPP No.	Project Title	Key Activities	Milestones	Outputs
93/0043	Seed biology, seedbank dynamics and the long term germ plasm storage of WA flora especially rare, threatened and commercially utilized 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.	**03/03** 50-60 more seed collections accessed into TFSC for duplication at RBG Kew. **06/03** Viability testing completed on 70% of collections. **09/03** Viability testing completed for 2001/2002 field collections. **03/03** Complete field collections. for 2002/2003,viability testing on 50% of collections.	1. Yearly and half yearly progress reports to NHT. 2. Yearly and half yearly progress reports to RBGKew. 3. Rare Flora report forms forwarded to Wildlife Conservation Section.
02/07	Declared Rare and Poorly Known Flora in the Goldfields Region, Wildlife Management Program	1. Create field work schedules for flowering seasons 2003. 2. Continue 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 4. Prepare population. assessments for all Priority 2 taxa.	**09/02** Species accounts prepared for 20 taxa. Complete rare flora report forms. Incorporate voucher specimens to WA Herbarium. **03/03** Complete fieldwork schedules for 50 taxa. Write species accounts for 30 taxa. **06/03** Prepare priority 2 population assessments.	1. Rare Flora report forms forwarded to Wildlife Conservation Section. 2. Completed species accounts forwarded to Region for additional information. 3. Recommendations to Wildlife Branch and Threatened Species Scientific Committee regarding changes in conservation status of target taxa where appropriate.
93/0068	Integrating strategies for the control of *Phytophthora cinnamomi* with phosphite	Determine longevity of action of phosphite in plants.	**10/02** Submit research proposal to NHT II. **12/02** Commence *Lambertia* study. **02/03** Submit final report to NHT.	Annual report to NHT. Final report to NHT.

			06/03 Review data for publication.	
98/0003	Genetics and biosystematics for the conservation, circumscription and management of Western Australian flora	1. Investigate possible hybrid origins of *Eucalyptus bennettiae* 2. Investigate possible hybrid origins of *Grevillea phanerophleba.* 3. Investigate possible hybrid origins of *Adenanthos cunninghamii*	**09/02** Sample populations of G. *phanerophleba* and putative parents. **12/02** Complete analysis of *E. bennettiae.* **03/03** Complete analysis of G. *phanerophleba.* **06/03** 1. Complete analysis of *A. cunninghamii.* 2. Submit journal paper on hybrid origins of *E. bennettiae.*	1. Report to WATSCU on hybrid status of *E. bennettiae.* 2. Journal paper on hybrid status of *E. bennettiae.* 3. Report to WATSCU on hybrid status of G. *phanerophleba*
99/0005	WATTLE, a computer-based information system for the genus *Acacia*	1. Commence construction of WATTLE Phase 2 database. 2. Prepare seminars & workshops on use and functionality of the WATTLE information & identification system. 3. Attempt to have name *Acacia* retained (through retypification) for the Australian species when the genus is split.	**09/02** Prepare scientific papers concerning the retypification of Acacia. **03/03** Commence construction of WATTLE Phase 2 (associated with Pilbara project).	1. Papers on retypification of Acacia. 2.Seminars/Workshops on use and functionality of the WATTLE identification and information system.
99/0019	Susceptibility of rare and endangered flora to *Phytophthora cinnamomi*	Record mortality following pot inoculation of rare and threatened flora.	**09/02** Grow on next batch of plants. **03/03** Inoculate next batch of plants & assess mortality. **06/03** Review data for publication.	1. Database of ranking of threatened flora susceptibility to *P. cinnamomi* updated yearly and distributed to relevant groups in DCLM. 2. Results presented at the IUFRO conference Nov 2001. 3. Publication in preparation.
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.	**9/02** Complete spring fieldwork. **12/02** Complete Report forms, incorporate voucher specimens and make recommendations in relation to taxa completed 2002. **3/03** Final report to NHT. Completed list and schedule of target taxa for 2003. **6/03** Complete 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.
00/0012	Wattles in the Dalwallinu Shire.	1. Publish book (a field guide to Wattles of Dalwallinu Shire). 2. Develop WorldWideWattle web site. 3. Assist development	**09/02** Attend planning meetings for DEIC. **12/02** Publish Acacia Symposium proceedings. **03/03** Develop prototype of	1. Proceedings of Acacia 2. WorldWideWattle web site available. 3. Publications on Acacia

		of Dalwallinu Environmental Interpretive Centre (DEIC	WorldwideWattle website. **06/03** Undertake field studies for book. Commence writing text.	
00/0015	The population ecology of critically endangered flora	1. Assessing limitations on population growth in Critically Endangered *Acacia* species. Reproductive and ecological attributes of the rare *Acacia.* Pollinator abundance, pollination rates and seed production in the rare *Verticordia* ssp. 2. Life history and population dynamics of the rare *V. fimbrilepis* ssp. *fimbrilepis, V. staminosa* ssp. *staminosa* and *Calytrix breviseta* ssp. *breviseta.* 3. Assessing the limitations on population growth in Critically Endangered flora in the Moora District. 4. The impact of fire regimes on the Critically Endangered East Stirling Range Montane Heath and Thicket Vegetation Community and its Critically Endangered plant taxa. 5. Landscape fragmentation and rare plant species: can we develop a general framework of population responses. 6. Impact of fire on endemic granite outcrop vegetation at Chiddarcooping Nature Reserve.	**09/02** Write up research on factors limiting population growth in *Acacia* species. Complete write up of research on impacts of fire on endemic granite outcrop vegetation. Begin ARC linkage project Landscape Fragmentation and Rare Plant Species. Begin population surveys and establish monitoring frameworks for Critically Endangered *Grevillea* and *Gastrolobium* spp. Write up research on the comparative population structure and reproductive biology of the Critically Endangered *Grevillea* spp. Undertake demographic census on *V. staminosa* ssp. *staminosa.* Complete review of the relationship between fire and rarity in South-west flora. **12/02** Write up research on pollination, seed production, demography and extinction vulnerability of *V. staminosa* ssp. *staminosa.* Monitor impacts of fire on East Stirling Range Montane Heath and Thicket Community and associated Critically Endangered Flora. Undertake demographic census of *V. fimbrilepis* ssp. *fimbrilepis.* **03/03** Definition and allocation of Declared Rare Flora to floral architecture/putative pollinator functional groups. Create database for East Stirling Range Montane Heath & Thicket fire project. Analyse data on effects of population size and landscape context on pollination and seed production in *Verticordia* ssp. Analyse data on seed bank dynamics, regeneration niche, and demography for *V. fimbrilepis* ssp. *fimbrilepis.* **06/03** Write up research on effects of population size and landscape context on pollination and seed production for *Verticordia* ssp. Write up research on seed bank dynamics, seed germination, regeneration niche, and demography for *Verticordia* ssp.	1. Publications on assessing limitations on population growth in 2 critically endangered *Acacia* taxa, rarity and threat in relation to the conservation of *Acacia,* comparative population structure and reproductive biology of the critically endangered shrub *Grevillea althoferorum.* Impact of two wild-fires 13 years apart on endemic granite outcrop mallee, shrublands, herbfields and rock oak woodlands in semi-arid south-west Western Australia. Fire as a determinant of rarity in the south-western Australian global biodiversity hotspot. 2. Recommended recovery actions and management prescriptions in Threatened Flora Recovery Plans
01/0001	Mating system	1. Mating system	**09/02**	1. Publication on genetic

	variation, genetic diversity, and viability of small fragmented populations of threatened flora and other key plants of conservation importance.	analysis and viability of small populations 2. Genetic variation in small fragmented populations	Finalize population genetic structure and mating system studies on *Verticordia fimbrilepis* **12/02** Submit for publication paper on 'Evolutionary patterns and genetic structure in rare and widespread species in a triggerplant (*Stylidium caricifolium*: Stylidiaceae) species complex' **03/03** Prepare paper on mating system variation and population genetic structure in *Verticordia fimbrilepis* **06/03** Finalize paper on population genetic structure and the mating system of the rare ghost wattle, *Acacia sciophanes* and its common congener *Acacia anfractuosa* **06/03** Finalize paper on patterns of genetic variation in *B. cuneata* and *B. oligantha*	consequences of rarity in a triggerplant species complex. 2. Reports and Journal papers on mating systems and genetic variation in *Banksia cuneata*, *Banksia oligantha*, and critically endangered *Verticordia* and *Acacia* species. 3. Recommended recovery actions and management prescriptions in Threatened Flora Recovery Plans.
01/0004	Experimental translocation of critically endangered plants	Experimental translocations of critically endangered plants.	**9/02** 1. Complete monitoring of 4 current translocations. 2. Undertake additional planting 4 translocations. 3. Undertake planting of one new plant translocation. **12/02** 1. Complete assessment of suitable sites for the translocation of 5 critically endangered flora. 2. Complete monitoring of a further 10 current translocations. **3/03** 1. Complete initial development of Flora translocation database. 2. Complete mating systems study on *Lambertia* translocation. **6/03** Undertake planting of 5 new experimental plant translocations.	1. Complete translocation proposals for 5 new plant translocations. Progress report to NHT on experimental plant translocations. 2. Presentation on experimental plant translocations to Australian Network for Plant Conservation Conference. 3. Final report to NHT on experimental plant translocations.
02/0001	Genetic and ecological viability of plant populations in remnant vegetation	1. Identify and quantify the genetic and demographic factors that affect the viability of plant populations in vegetation remnants. 2. Examine and model the relationships between key genetic and demographic factors affecting viability and remnant vegetation. 3. Develop specific genetic and	**09/02** Completion of analysis of site / population characteristics – disturbance, connectivity, density. **3/03** 1. Completion of seed set / reproductive output analysis for year 1 for *C. quadrifidis* and *E. wandoo* 2. Completion of genetic variation studies covering all populations of *C. quadrifidis* and *E. wandoo*. **6/03** Development of microsatellite	1. Preparation of publication on genetic variation and reproductive output in fragmented populations of *Eremaea pauciflora*. 2. Milestone report to Land and Water Australia.

		demographic guidelines for management of remnant populations in fragmented landscapes.	markers for *E. pauciflora* and *C. quadrifidis*.	
CP 3/2002	Acacia biology, conservation and utilization	1. Investigate variation patterns in *Acacia microbotrya*. 2. Investigate variation patterns in *A. saligna*. 3. Assess potential of *Acacia* as woody crops in southern Australia (for salinity control). 4. Re-assess conservation status of W.A. *Acacia* flora.	**9/02** Morphometric analysis of *A. microbotrya;* field study of *A. saligna*. **12/02** Report on *Acacia* crop potential **6/03** Design, scope and commence conservation reassessment sub-project.	1. Journal paper and report (to FCP) on variation in *A. microbotrya*. Report (to NHT) on variation in *A. saligna*. 2. Report (to RIRDC) on woody crop potential of *Acacia*. 3. Recommended actions for *Acacia* conservation taxa.

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.
- Improved ability for landholders and managers to assess the viability of remnant plant populations based on limited knowledge of remnant characteristics and species life history.
- Clear goals regarding remnant size and landscape configuration that maximize regional persistence of plants species.
- Identification of knowledge gaps in our understanding of relationships between vegetation remnant characteristics, species life history traits and plant population viability.

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.
- Results and recommendations for the management of remnant vegetation will be communicated to DCLM District and Regional staff, other land management agencies, and NGOs through presentations

and reports, as well as feeding directly into the development of strategies and methodologies as part of the Western Australian Salinity Strategy, and Threatened Flora Recovery and Threatened Ecological Community Recovery Programs.

Partners/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
- Edith Cowan University
- Southern Cross University
- CSIRO
- Royal Botanic Gardens Kew, UK
- Land and Water Australia
- Australian Network for Plant Conservation

Staff

Staff	Position	Location	FTE
M. Byrne	Principal Research Scientist	Kensington	0.5
D. Coates	Senior Principal Research Scientist	Kensington	1.0
A. Cochrane	Senior Research Scientist	Kensington	1.0
B. Maslin	Senior Principal Research Scientist	Kensington	0.8
S. Patrick	Senior Research Scientist	Kensington	1.0
B. Shearer	Principal Research Scientist	Kensington	1.0
C. Yates	Senior Research Scientist	Kensington	1.0
L. Monks	Research Scientist	Kensington	1.0
P. Gioia	Senior Research Scientist	Kensington	0.1
Scientists			**7.4**
C. Crane	Senior Technical (Officer)	Kensington	1.0
A. Crawford	Technical Officer (external)	Kensington	1.0
C. Elliott	Technical Officer (external)	Kensington	1.0
R. Fairman	Technical Officer	Kensington	1.0
B. McDonald	Technical Officer	Kensington	0.5
P.Van Heurck	Technical Officer	Kensington	0.5
Technical Officers			**5.0**
Total			**12.4**

Program 3 Disturbance Ecology and Management

Program Leader Dr Stuart Halse
Output Purchaser Nature Conservation

Key Result Area
Biodiversity inventory and conservation assessment.

Description
This program contributes to the understanding of the 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 studied include fire, grazing, mining and related clearing, flooding and changes to water quality. Fire is seen as a major management issue for which more information on impacts and appropriate frequency is required, especially outside the south-west. The current array of fire-related SPPs reflect a range of DCLM Regions

(Kimberley, Pilbara, Goldfields, South Coast, Wheatbelt, Central Forest, Southern Forest) and biomes (tropical savanna, spinifex deserts, arid woodlands, mesic shrublands and south west forests) but the amount of research effort, and the scope of the studies, needs to increase.

Long-term monitoring of change in wetland biodiversity in the Wheatbelt, as part of the State Salinity Strategy, is another priority for the program and collaboration with the CRC for Plant Based Management of Dryland Salinity is being undertaken.

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

Significance and Benefits
A critical element of DCLM'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
- An understanding of the impacts of various ecological disturbances, including fire, salinization, flooding and grazing on biodiversity.
- Identification of best practice in management of the conservation estate and off-reserve areas including minimizing deleterious disturbances and restoration.
- A sound knowledge of the application of disturbance ecology principles at the landscape level.

Performance Indicators
- The maintenance of ecological processes throughout the DCLM estate.
- An increase in the value of rehabilitated disturbed areas to biodiversity conservation.

Tasks / Activities – Relevant Science Project Plans

SPP No.	Project Title	Key Activities	Milestones	Outputs
99/0016	Monitoring impacts of Dawesville Channel on waterbird usage	Undertake and analyse current and historical waterbird count data.	**06/03** Finalize reports.	Report on changes in waterbird use pre- and post channel.
93/0075	Effects of autumn and spring burning on small vertebrates in jarrah forest	No field activity 02/03, prepare Fire Symposium chapter.	**06/03** Publication of Fire Symposium chapter.	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.
93/0141	Fire-mulga study	Undertake review of previous research. Continue monitoring burnt / unburnt areas.	**06/03** Transects run, trapping.	Publication of existing data.
93/0092	Fire effects on desert vertebrates	Long term monitoring of the impacts on vertebrate fauna of fires in summer and spring in hummock grassland in the Great Victoria Desert, including the Sandhill dunnart, *Sminthopsis psammophila*.	**12/02** Preparation of manuscript on short-term impacts on reptile guilds. **03/03** Trapping/monitoring of study area. **12/02** Completion of	Manuscript on the impact of fire on hummock grassland reptiles. Workshop with DCLM Goldfields Region staff on managing fire for conservation in desert lands.

			manuscript on fire impacts on reptiles.	
98/0018	Wheatbelt wetland monitoring – State Salinity Strategy	Monitor vegetation condition, waterbirds, invertebrates, surface and groundwater quality.	**05/03** Annual vegetation report. **12/02** Waterbird and invertebrate report	Reports on plant, waterbird and invertebrate monitoring Information for Recovery Catchment management. Advice to landholders
99/0012	Silver gull monitoring	Annual count on Carnac and Shoalwater Bay Islands.	**06/03** Write up of last 3 yrs data.	Population estimates and basis for potential control strategies.
00/0001	Integrated overview of values, uses and modifying processes in the Ord River riparian zone.	Write up, field work completed.	**06/03** Publication.	Publications and information for WRC water allocation plans for Ord and monitoring of plan.
00/0004	Demography of Australian boab (*Adansonia gregorii)* stands in relation to grazing and fire.		**06/03** Publication.	Publication and information for regional strategies on fire.
00/0008	Mistletoes and their fire ecology in Western Australia	Collect opportunistically. Maintain database Send herbarium sheets to PERTH.	**06/03** Complete identifications.	Publish Mistletoe – fire ecology paper for Pilbara. Description of new taxa.
99/0015	Monitoring benthic invertebrate communities of tropical intertidal mudflats	Identify species, quantify distribution and abundance.	**06/03** Report on Anna Plains work.	Information for management of Ramsar sites and migratory shorebirds.
No SPP	Impact of fire in old grwoth forest on invertebrate endemics	Field work – ongoing sampling.	**06/03** Report.	Information for management of fire on fire sensitve fauna.
No SPP	Fire impacts on biodiversity in the Kimberley	Field work – mammal survey of previous sites.	**06/03** Undertake fieldwork to NW Kimberley.	Information on impact of frequent and extensive fires on Kimberley mammal fauna.

Anticipated Outcomes

- Fire management of DCLM estate and off-reserve conservation areas (particularly in Kimberley, Pilbara and Goldfields) will be based on an increased understanding of impact on biodiversity and regeneration processes.
- Appropriate rehabilitation techniques will be applied to the management of disturbed estate.
- Management of wetlands, and other aquatic areas, will be based on a good understanding of the natural and man-induced disturbances causing changes to the quality of these areas.

Adoption Strategy

- Liaise with staff from DCLM's Regional Services and Nature Conservation Divisions, land-holders including those with responsibility for off-reserve conservation areas, staff from the Department of Environmental Protection and Department of Agriculture on disturbance management issues. Continue to promote the findings of the studies in this program through publications, seminars, meetings, committee membership, advice to Nature Conservation Division etc.

Some specific adoption strategies for this program include:

- Participation in the ongoing review of fire management in the south west of WA.
- Outcomes of the fire–desert work can be adopted by operations staff in the Goldfields Region (already a progressive process); and used for the production of management plans for desert nature reserves and background data for workshops/discussions between DCLM and other land-holders.
- Outcomes from the Tutanning fire study will be adopted through input into the Wheatbelt Regional Management Plan. Knowledge will be made available to Wheatbelt regional staff (and other people) through ongoing liaison.

- Outcomes of the Mulga fire study will be adopted through communication with DCLM planning teams and managers as well as through liaison with external agencies and development proponents e.g. Department of Environmental Protection (and the EPA), Department of Resource Development and Department of Minerals and Energy, Hamersley Iron Pty Ltd and BHP Pty Ltd. Contribution to the development of the Pilbara Fire Planning Team's burning proposals, assistance of regional staff with the development and maintenance of Wildfire Threat Analysis maps, Fire Control Working Plans and burning (hand and aerial) programs within the Hamersley Range conservation estate.
- Outcomes of the Kimberley fire study will be adopted through communication and liaison with pastoralists, traditional owners and other relevant government agencies.

Partnerships/Collaborators
In delivering of services, this program will enter into collaborative arrangements with the following organizations:
- Department of Agriculture
- Botanic Gardens and Parks Authority
- University of Western Australia, Murdoch University, Curtin University, Edith Cowan University
- CSIRO
- Tropical Savanna CRC
- Dryland Salinity CRC

Staff

Staff	Position	Location	FTE
S Halse	Senior Principal Research Officer	Woodvale	0.10
N Burrows	Director	Kensington	0.01
A Hopkins	Principal Research Scientist	Woodvale	0.25
L McCaw	Principal Research Scientist	Manjimup	0.05
J Lane	Principal Research Scientist	Busselton	0.10
I Abbott	Senior Principal Research Scientist	Kensington	0.10
N Gibson	Principal Research Scientist	Woodvale	0.05
D Pearson	Principal Research Scientist	Woodvale	0.20
AN Start	Principal Research Scientist	Woodvale	0.80
S van Leeuwen	Research Scientist	Karratha	0.20
M Lyons	Research Scientist	Woodvale	0.50
M Langley	Technical Officer	Woodvale	0.30
Y Winchcombe	Senior Technical Officer	Busselton	0.40
B Bromilow	Technical Officer	Karratha	0.20
B Johnson	Principal Technical Officer	Woodvale	0.10
C Ward	Senior Technical Officer	Manjimup	0.10
G Pearson	Principal Technical Officer	Woodvale	0.10
P van Heurck	Technical Officer	Kensington	0.50
A Clarke	Technical Officer	Woodvale	0.60
D Cale	Technical Officer (external)	Woodvale	0.60
Total			**5.26**

Program 4 — Biological Survey & Reserve System

Program Leader — Norm McKenzie
Output Purchaser — Nature Conservation

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

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, broadscale, zoological and botanical survey of the bioregions of WA. The program has recently published the results of the Carnarvon Basin survey and is presently writing up the biological survey of the wheatbelt as part of the Salinity Action Plan. The Pilbara IBRA region is the next priority for survey. An array of smaller projects are undertaken in parallel with the regional surveys: surveys of localized 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 DCLM. 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

- Field work will commence on the Pilbara biological survey.
- Data matrices will be compiled and archived on species composition and physical attributes at a representative set of sites throughout the Wheatbelt, Goldfields, Burrup Peninsula, Nimbing Ranges, Oscar-Napier Ranges, Pilbara, coastal Warren Region, Cape Arid NP, Karijini NP uplands, Barley Range NR, Pilbara tussock grasslands, western Little Sandy Desert, Byenup-Muir wetlands, inter-tidal mudflat community of Eighty Mile Beach and Darling Scarp.
- Reports, papers or books with management or land-use recommendations/implications will be drafted, submitted or published on Wheatbelt biodiversity-salinity, Little Sandy Desert 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, and a biodiversity audit of WA's IBRA sub-regions.
- 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 (environmental domain models of species assemblages), affect of salinity on community composition, new flora species, new WA copepods, distributions of WA ostracods, faunas of saline floors in the wheatbelt, biogeography and taxonomy of stygofauna and ground-dwelling spiders, cross-taxon congruence, Lyssavirus and other pathogens carried by WA bats, Karijini management taskforce, bat echolocation signatures, Directory Of Important Wetlands in Australia 3rd Edition, substrate-type and invertebrate biomass of 80-Mile Beach mudflats, bat flight morphology and foraging strategies.

Tasks / Activities

SPP No.	Project Title	Key Activities	Milestones	Outputs
93/0028	Ecomorphological clues to community structure: Bat and lizard guild studies, bat echolocation studies.	Finalize paper on echolocation of Little Sandy Desert bats. Prepare paper on flight speed/power of WA bats. Publish paper on structure of Little Sandy Desert bat fauna; environmental productivity as a factor determining faunal composition. Sample Lyssavirus (bat rabies) in south-western WA.	**02/03** Paper on Little Sandy Desert bats published. **06/03** Paper on wing-beat of WA bats published.	Train forest monitoring staff on surveying bat assemblages using echolocation call signatures. Recommend on warning signs / inoculations in relation to bat rabies.
93/0030	Biological survey of	Write various papers.	**06/03**	Publications in Conservation

	the Barlee Range Nature Reserve		Final report re-submitted for publication in Conservation Science.	Science.
93/0031	Botanical survey of the Hamersley Range uplands	Prepare scientific publications.	**06/03** Scientific paper(s) submitted for publication.	Advice to other DCLM Divisions. Advice to external government and non-government agencies. Deliver seminars to interested community groups.
93/0034	A biological survey of Cape Arid National Park	Produce written report for regional planning staff.	**06/03** Submit MS for publication.	Scientific paper in Conservation Science. Report to regional planning staff.
93/0162	Aquatic Invertebrate Surveys and Atlas	Document distribution, 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.	**06/03** Submit MS for publications.	Clearer understanding of micoinvertebrate biodiversity in WA. Better information about level of endemism in microinvertebrate fauna. Information on environmental tolerances of the microinvertebrate fauna.
94/0003	Conservation of Western Australia's vegetation assemblages	Develop and maintain vegetation map database. Develop and maintain database of conservation statistics. Provide conservation assessment reports to DCLM staff and to community organizations. Links with Gascoyne Murchison strategy.	Ongoing, provision of information as requested.	Scientific publications. GIS data sets provided to clients. Technical reports on database. Rreports on individual conservation assessments as required.
98/0020	Biological Survey of the Agricultural Zone	Prepare draft papers.	**04/03** All drafts submitted. **06/03** All drift fences cleaned-up.	Participation in communications strategy. Results provided to managers via reports and seminars.
99/0001	Biological survey of the Burrup Peninsula	Finalize flora chapter. Co-ordinate other authors to production of report.	**06/03** Draft report for funding agency.	Recommendations for management of Peninsula made to Burrup Mgmt Committee.
99/0002	Botanical survey of the Pilbara tussock grasslands	Develop GIS themes.	**06/03** Draft report completed.	Advice to external government and non-government agencies. Benchmark quadrats for central Hammersley Range.
99/0003	Biological survey of the Little Sandy Desert	Prepare paper on flora.	**06/03** Paper refereed.	Implementation of recommendations
99/0004	Karijini taskforce	Liaison with mining companies and government agencies. Update draft publication.	**06/03** New KNP GIS atlas produced.	Additions to Karrijini NP. Advice to other DCLM divisions. Advice to external government and non-government agencies. Seminars delivered to interested community groups.
99/0015	Tropical inter-tidal benthic invertebrate communities	Publish paper.	**06/03** Paper published.	Recommendations available to managers.
No SPP	Salty floor fauna	Pit trap survey of fauna on salty floor units of SAP region.	**06/03** Report to SAP Committee	Recommendations on affect of salinity drainage.
00/0009	Identifying Land with High Nature Conservation Values in the Gascoyne-Murchison Strategy	Field surveys of biodiversity hotspots Assess individual properties based on GIS analysis of vegetation mapping data. Establish	**06/03** Monitoring sites contributed to WARMS **12/03** Scientific publication on regional	Conservation assessment reports to NC Division for individual pastoral properties offered for sale, in relation to the rest of the reserve system. Regional biodiversity

	Area	monitoring sites on acquired properties.	assessment. As required –conservation assessment reports of properties for acquisition.	assessment report. Database supplied to G-MS Board and regional groups. Scientific publication.
02/04	Pilbara Regional Survey	Initiate preparation for surface survey & finalize first stygofauna & surface biota sampling sessions.	**06/03** 1. First year of stygo sampling completed. 2. Site selection and strategy for trap installation finalized.	Funding liaison with C/W & industry.
No SPP	Biodiversity Audit	Up-date synopsis, summary and case study reports; have reports reviewed, then publish as DCLM reports. Improve sub-fossil data-set and prepare MS on mammal decline patterns.	**06/03** Report with printer. **04/03** Planning for central Kimberley sub fossil survey completed.	Framework assessing nature conservation priorities for regions.

Anticipated Outcomes

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 properties 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 region 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). Delivery of the biodiversity audit as a framework for nature conservation planning across the regions of WA is a significant step towards an integrated biodiversity conservation strategy in WA.

Adoption Strategy

Notify and liaise with Department of Agriculture, development proponents, land-holders, Department of Environmental Protection, Department of Resources Development, and other branches of DCLM, on species with conservation problems, areas of high biological value, fire management planning consequences etc as indicated in the above table of projects. Continue to promote findings of the studies through publications, seminars, meetings, committee membership, and advice to Nature Conservation Division.

Examples of liaison include workshops on stygofauna, salinity-effects on biota and scoping parameters for the proposed Pilbara survey, 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 completed; 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,
- University of Western Australia,
- Edith Cowan University,
- R. Bullen, Queensland
- Department of Primary Industries,
- Charles Sturt University,
- WA Department of Agriculture and
- Environment Australia.

Staff

Staff	Position	Location	FTE
AH Burbidge	Senior Research Scientist	Woodvale	0.9
N Gibson	Principal Research Scientist	Woodvale	0.9
S Halse	Senior Principal Research Scientist	Woodvale	0.8
A Hopkins	Principal Research Scientist	Woodvale	0.5
G Keighery	Principal Research Scientist	Woodvale	0.8
A Pinder	Research Scientist	Woodvale	1.0
J Lane	Principal Research Scientist	Bussleton	0.2
S van Leeuwen	Research Scientist	Karratha	0.8
M Lyons	Research Scientist	Woodvale	0.5
N McKenzie	Senior Principal Research Scientist	Woodvale	1.0
B Bromilow (BB)	Technical Officer	Karratha	0.7
A Clark	Senior Technical Officer	Woodvale	0.7
B Durrant	Technical Officer (external)	Woodvale	1.0
N Guthrie	Technical Officer (external)	Woodvale	1.0
M Langley	Technical Officer	Woodvale	0.2
J McRae	Technical Officer (external)	Woodvale	1.0
W Muir	Senior Technical Officer	Woodvale	0.8
G Pearson	Principal Technical Officer/Centre Manager	Woodvale	0.2
J Rolfe	Senior Technical Officer	Woodvale	0.9
Total			**14.1**

FORESTS & TREE CROPS GROUP

KEY SCIENCE THEME

Sustainable utilization of woody perennials in Western Australia's revegetation, native forest, and plantation systems. Science Division will provide the scientific basis to ensure that the State's revegetation, native forest 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 revegetation and plantations for environmental services and commercial products will be provided.

AIM

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

PROGRAMS

- Ecologically Sustainable Forest Management
- Environmental services
- Revegetation Systems

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 DCLM'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, DCLM
Forest Products Commission

Program Leader Dr Lachlan McCaw, Manjimup

Description

This program contributes directly to the objectives of the Sustainable Forest Management Division to maintain and enhance biodiversity and other values in publicly-owned forests; and to provide for harvesting, regeneration and growth of forest products from State forests and timber reserves in accordance with approved forest management plans and principles of ecologically sustainable forest management (ESFM).

The ESFM Program integrates a series of related projects that investigate the impact of disturbance (principally fire and harvesting) on soil, water yield and quality, microbiota, flora and fauna of the forest. The impact of forest management on the sustainability of the forests is being examined using a system of Integrated Forest Monitoring (FORESTCHECK). Silvicultural management systems will be developed to maximize the productivity from karri regrowth forests. The Department's Vegetation Health Service (Disease Detection) is also located in this program.

The ESFM Program has 4 broad areas of activity: Forest Management; FORESTCHECK; Fire Management, and the Vegetation Health Service

Forest Management
This sub-program integrates a series of related Science Project Plans that address aspects of ecologically sustainable forest management including:

Forest microbiota
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 Skeletonizer, Lerps and stem wood borers are being finalized 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.

Forest hydrology
The effect of current silvicultural practices on the yield and quality of water from forested catchments in the intermediate rainfall zone of the Jarrah forest is being studied experimentally using a Before/After/Control/Impact design involving 3 small catchments. These catchments have been instrumented to monitor rainfall, groundwater level and streamflow, and have pre-treatment records that extend back more than 20 years.

Silviculture
Research in karri forest is focused on the understanding the development of even-aged stands following timber harvesting. A combination of detailed experimental studies and chronosequence investigations is being used to provide a medium to long term perspective on the dynamics of stand structure, and plant and animal populations of the life cycle of a karri forest.

In the jarrah forest, a major study of the characteristics of hollow-bearing jarrah and marri trees and coarse woody debris is nearing completion, and a series of inter-related papers have recently been published. Information gained from this study will be used to evaluate the adequacy of fauna habitat retention measures proposed in the draft Forest Management Plan. An externally funded investigation into the evaluation of key soil indicators for sustainable forest management has also recently been completed, but several manuscripts remain to be submitted for publication. Work is continuing at a maintenance level on a study into the effect of stand density and fertilizer application on the fall of fruits, flowers and other floral parts in a jarrah pole stand thinned to a range of stand densities.

Ecology of arboreal mammals in jarrah forest
A major study into the ecology, habitat usage and distribution of the Ngwayir (Western ringtail possum) and Koomal (Brushtail possum) in the jarrah forest commenced in June 2001. This study follows on from the Kingston Project which examined the impacts of current timber harvesting practices in the jarrah forest, and identified that arboreal mammals were potentially vulnerable to decline because of the effects of predation and the change in habitat condition. For this reason, a specific study into the ecology of these two possum species was regarded as a high priority. This study provides the basis for a PhD program being supported by the Science Division, in association with the Australian National University.

FORESTCHECK
FORESTCHECK is an integrated monitoring system that has been developed to provide information to forest managers in south-west Australia about changes and trends in key elements of forest biodiversity associated with a variety of forest management activities. Although the initial focus of FORESTCHECK will be on timber harvesting and silvicultural treatments in Jarrah forest, the intention is to extend the scale of monitoring over time to include other forest ecosystems, fire (prescribed and wildfire), mining, the effects of forest disturbance for utility corridors (e.g. roads, power transmission lines), and the impacts of recreation uses.

Fire
Since 1996 DCLM and the Bushfire Research and Management Group of CSIRO Forestry and Forest Products have collaborated in a major experimental study to determine the effect of fuel age and loading on

fire behaviour in the jarrah forest. All experimental burning was completed by February 2001, and data analysis is well advanced. The completion date for delivery of a final project report is June 2003, and the scientific team is on schedule to meet this target. Several issues that are critical to firefighter safety have already been identified and widely publicized throughout fire and land management agencies.

Long term fire ecology research in jarrah forest sites spanning a gradient of average annual rainfall from 800 to 1200 mm is continuing, and 3 study sites are currently being utilized in a study of the effects of a range of fire regimes on soil carbon and nitrogen.

Monitoring of post-fire responses of flora and fauna, and of eucalypt regeneration is being undertaken within karri-tingle forest in the Walpole-Nornalup National Park in collaboration with Frankland District.

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 DCLM and FPC.

Objectives
Forest Management

- To determine the short term effects of timber harvesting and associated silvicultural treatments, including prescribed fire, on plants and animals in the jarrah forest.
- To better understand the ecology, distribution and habitat requirements of Ngwayir (Western ringtail possum) and Koomal (Brushtail possum) as a basis for developing landscape management guidelines that provide for the maintenance of viable populations of these species in the presence of timber harvesting
- To determine the effects of timber harvesting 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 timber harvesting and the related responses of flora and fauna, including birds, invertebrates, vascular plants, cryptograms and fungi.
- 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 characterize wind speed profiles in forests with different overstorey and understorey structures.
- To describe trends in populations of vascular plants, birds and small vertebrates following an intense summer fire in long unburnt karri-tingle forest.

Vegetation Health Service (VHS)

- To provide a *Phytophthora* detection service to assist managers of forests, plantations, parks and reserves.
- To help maintain and protect the State's vegetation resource by providing accurate diagnosis of the cause of plant disorders and advice on their management.
- To maintain awareness of diseases which represent a potential threat to plants, especially those of economic or conservation importance.
- To provide input to the State's Forest Health Advisory Committee, and assistance in dealing with plant disease outbreaks.

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 addresses the response of ecosystem components and processes to disturbance associated with timber harvesting and fire. Information gained from these studies contributes directly to the Department's compliance reporting against Ministerial Conditions, and has been applied during the development of the new Forest Management Plan.

FORESTCHECK

- FORESTCHECK is a simple, practical, credible and integrated system that provides information about trends in populations of forest flora and fauna over time in areas subject to a range of management treatments. FORESTCHECK has been developed to meet a range of compliance conditions placed on the Forest Management Plan 1994-2003 through Ministerial Conditions and the Codd Report of 1999. Integrated monitoring is a fundamental component of ESFM, and is necessary for reporting against the Montreal Process criteria and indicators. In addition, monitoring forms the basis for adaptive management, which is recognized as an appropriate strategy for managing under conditions of uncertainty and change.

Fire

- Prescribed fire is used extensively in WA forests for fuel reduction and to meet silvicultural objectives. Annually, DCLM undertakes prescribed burning over more than 150 000 ha of forest. The use of prescribed fire is opposed by some environmental and community groups 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 effects of fuel age and fuel characteristics on fire behaviour so that the effectiveness of fuel reduction burning can assessed.
- 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.
- The Department is currently reviewing its fire management policies and programs with the aim of placing a stronger focus on achieving biodiversity conservation objectives through the use of planned fire. More targeted use of fire for biodiversity conservation will require decision support systems that make information about ecological principles and fire response attributes available to managers in accessible and timely formats.

Vegetation Health Service (VHS)

- Accurate detection of *Phytophthora* infections is essential for the Department's Dieback Interpreters to assist them in making the operational decisions regarding the boundaries of infected areas, and in selecting road alignments.
- VHS maintains a comprehensive computerized database of information on the distribution of *Phytophthora* species and their host plants throughout WA, which is available to managers.
- VHS maintains and continues to develop a reference collection of *Phytophthora* cultures which is available to researchers.
- Diagnosis of other plant diseases and provision of advice regarding their management 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.
- Improved predictions of the impact of forest fuel age and condition on fire behavior.
- 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	Finalize MS. G.Friend contracted to do this.		MS containing advice on the effects of fire

	invertebrates in jarrah forest			regimes on invertebrates in jarrah forest.
93/0095	Characteristics of hollow-bearing jarrah and marri and their use by selected fauna	Publication of papers in external journals (hollow occurrence, selection of trees for hollow retention). Preparation of chapter on management of hollows for wildlife in WA's forests for publication in book on Australia's forest fauna.	**112/02** All MSS from this project either published, or submitted for publication.	Predictive models for hollow abundance and dimensions. Input to draft Forest Management Plan and revision of silvicultural guidelines.
93/0098	Effects of fire and logging on floristic composition and structure of jarrah forest vegetation (Kingston)	Field work completed. Analyse data and write-up	**03/02** First 4 yrs of post-treatment data analysed and published.	Publications in scientific journals. Input to draft Forest Management Plan and revision of silvicultural guidelines.
93/0106	Increasing productivity of karri regrowth stands by thinning and fertilising	Sutton thinning experiment re-measured in January 2002. 10 yrs post-treatment now available for all experiments. Analyse the full 10 yrs data.	**6/03** Analysis of data from Warren thinning experiment to examine impact of *Armillaria* on stand growth.	Report on effects of thinning on growth of high quality regrowth at Warren. Data available for validation of current growth models.
93/0115	Effects of timber harvesting on terrestrial vertebrates in medium rainfall jarrah forest (Kingston)	Prepare manuscript on Chuditch bait trial.	**03/03** MS on Chuditch bait trial submitted for publication in external journal.	Input to draft Forest Management Plan and revision of silvicultural guidelines. Contribution to DCLM's public information program about the effects of timber harvesting on forest fauna by means of written material and oral presentations.
94/0007	Effects of timber harvesting on invertebrates in jarrah forest	Research phase of project completed. Input to draft Forest Management Plan and revision of silvicultural guidelines.	**12/02** 2 publications in Forest Ecology & Management.	Input to draft Forest Management Plan and revision of silvicultural guidelines.
94/0008	Effects of timber harvesting on birds in karri forest	Maintain transect lines in a trafficable condition for 20 yr post treatment census (06/05).	**06/03** Transect lines maintained in a trafficable condition.	Input to draft Forest Management Plan and revision of silvicultural guidelines.
99/0009	Using ground-based electro-magnetic induction to measure forest soil salt storage	Research phase of project completed.	**06/03** Transfer of technique to operational basis.	Report 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	Commence monitoring of crown scorch, fuel consumption and stream-flow following completion of post harvest burning.	**06/03** Internal report to Director of Science Division and Waters and Rivers Commission.	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)	Write scientific papers based on final project report submitted to Forest & Wood Products R&D Corporation.	**06/03** Submit 2 MSS for journal publication.	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. Increase knowledge and technical expertise in the use of these indicators in the forests of WA.
02/0002	Ecology of ngwayir and koomal in the jarrah forest	Improve trapping methods and initiate life history and habitat selection studies.	**03/03** Study of distribution and abundance of Ngwayir and Koomal in Greater Kingston area commenced.	Input to draft Forest Management Plan and revision of silvicultural guidelines. PhD thesis integrating a wide range of issues relating to arboreal mammals.
Microbiota				
RPP 24/86	The impact of repeated defoliation's on the wood growth of jarrah saplings	Complete sampling for Year 15 of repeated defoliation. Data entered into database and plotted to show trends in growth.	**12/03** Monitor growth. **03/03** Update graph of results.	Updated graph showing difference in growth of intact and defoliated saplings.
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.	Submit paper for publication.	**12/02** Have paper accepted for publication.	Paper published in *Pacific Conservation Biology*.
93/0097	Control of Jarrah leafminer: Selective retention of JLM resistant trees and ground coppice in a demonstration forest plot	Coppice removal completed on part of original harvest coupe.	**06/03** Tend site and cut back coppice shoots susceptible to JLM.	Demonstration site showing benefits of selective retention of JLM-resistant as a silvicultural technique. Reference photographs showing changes in condition of individual trees over time.
93/0103	Quantitative population monitoring of Gumleaf skeletonizer *Uraba lugens* and impact assessment on	Field work complete, most data analysis complete. Population data measured by cherry-picker sampling to be written-up.	**12/02** Publication of paper on biology of *U. lugens* in *Aust. J. Entomology*. **06/03** Draft MS on GLS population monitoring approved for	Journal paper on biology of *U. lugens*.

	jarrah crowns		publication.	
93/0104	Distribution of Gumleaf skeletonizer in the central and southern forest regions.	Finalize and submit paper.	**03/03** Submit MS on GLS outbreak in relation to vegetation type, logging and fire history for publication in *Australian Forestry.*	Journal paper on outbreak of *U. lugens* in southern forests published in scientific journal.
93/0105	The influence of pheromones in the mating behaviour of *Tryphocaria acanthocera* (Coleoptera: Cerambycidae)	Finalize and submit report.	**06/03** Draft MS available for review.	Report on potential of pheromone traps for limiting attack of *T. acanthocera* in Karri regrowth stands
94/0007	Effects of timber harvesting on invertebrates in Jarrah forest (Kingston)	Submit paper.	**03/03** Publication of paper in *Forest Ecology and Management.*	Scientific paper on the effect of timber harvesting and burning on Jarrah forest invertebrates.
01/0003	Landscape and fire management interactions and their effects on distribution of invertebrate biodiversity.	Study sites established in Helena and Serpentine valleys. Pitfall trapping completed in spring 2001, and data sorted to ordinal level during 2002.	**06/03** Sort specimens to morphospecies level and analyse patterns.	Scientific paper documenting the distribution and abundance of invertebrates, and examining whether landscapes provide natural refuges for invertebrates in the northern Jarrah forest.
Not allocated	Biology of the psyllid *Cardiaspina jerramungae* on Flat-topped yate in the lower Great Southern	Field work completed. Data validated and analysed. Manuscript in preparation.	**6/03** Draft MS available for review.	Scientific paper describing the life cycle of the insect, and indicating factors possibly linked to outbreak.
98/0006	Below ground incidence of *Armillaria luteobubalina* in regrowth karri	Manuscript on below ground incidence of ARD accepted for publication in *Australian Forestry.*	**9/03** Select additional sites for validation of technique.	Scientific paper on below ground ARD. Improved guidelines for surveys of ARD in regrowth Karri stands.
98/0015	Effect of fire on the fruiting of fungi on karri regrowth forests	Re-sampling of study sites to be completed during 2002, 5 years post-fire. Convert to a monitoring study with next sampling due 2008.	**12/02** Resampling complete.	Landscope article. Chapter for book on Fire in South-west Australian Ecosystems growth. 3 annual progress reports.
Not allocated	Effect of thinning on *Armillaria* root disease in Karri regrowth	Analysis of data quantifying the impact of thinning on ARD, and the effect of ARD on growth in the Warren Thinning Trial.	**12/02** Paper submitted for publication in *Forest Ecology and Management.* **6/03** MS prepared examining impact of ARD on stand and tree growth.	Scientific paper of ARD in relation to thinning intensity in Karri. Recommendations to management about control of ARD in thinned Karri stands.
TBA	Mundella Yellows (MY) disease in Western Australia	Survey incidence and monitor spread of MY in urban and rural ecosystems.	**12/02** Expanded survey and established transects; samples sent to University of Adelaide for testing.	Occurrence of MY documented. Progress Report. Transects established to monitor spread. Representation on

			6/03 Survey and yr 3 observations complete; review status and write report.	national MY task group reporting to LWBC.
Fire Management				
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.	**12/02** MS prepared for Fire Symposium book.	Interactive database listing ecological attributes & fire response of plants in south-west forests & shrublands. Paper on effect of repeated fire on floristics and structure of jarrah forest understorey at 3 contrasting sites. Paper on time to first flowering & seed production for selected plant species in jarrah forest. Input to draft Forest Management Plan and DCLM Fire and Biodiversity project
96/0010	Fire history and impact of *Phytophthora cinnamomi* in jarrah forests	Data to be analysed and written up.	**6/03** Draft report in preparation	Report on the interactions between fire and *Phytophthora cinnamomi* in jarrah forests
97/0003	Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest	Experimental fires completed in January 2001. Data on fuel characteristics, fire spread and bark consumption have been analysed, and a preliminary fire spread model is under development. Prepare presentations for practitioners and policy makers in each participating State. Prepare papers to be presented at International Wildland Fire Conference Sydney.	**6/03** Final report to be presented to Australasian Fire Authorities Council.	Annual progress reports to DCLM and 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.
FORESCHECK				
Not allocated	FORESTCHECK – integrated monitoring of biodiversity in south-west forests	Ten sampling grids established and assessed in southern Jarrah forest (Donnelly District) during spring 2001and autumn 2002. Nine sampling grids established in northern Jarrah forest (Wellington District) during spring 2002.	**06/02** Results discussed at a seminar and presented in a progress report. **12/02** Operating Plan revised.	Annual report on biodiversity monitoring. Papers describing patterns in distribution and abundance of key groups of organisms. Report on population trends over time, based on repeat sampling of permanent sites.
Vegetation Health Service (VHS)				
N/A	Provision of *Phytophthora* (dieback) diseases detection and general plant	Processing of plant and soil samples for fungal pathogen detection and identification (particularly *Phytophthora*). Provide advice on plant disorders	**06/03** Ongoing support provided to Dieback Interpreters by timely processing of samples. Maintain corporate	Results of pathogen assessments on plant and soil samples throughout WA. Databases of *Phytophthora*

	disease diagnostic service to DCLM and FPC	to Departmental and external clients.	database of *Phytophthora* distribution in WA. Maintain culture collection.	distribution in WA available to managers. *Phytophthora* collection available to researchers. Annual open day for DCLM'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 maintain populations of fauna that may be adversely impacted by harvesting operations.
- Jarrah silvicultural guidelines have been refined to minimize adverse impacts on soils and understorey vegetation.
- Ecological and silvicultural characteristics of even-aged stands of Karri at different stages of stand development have been documented, and the responses to silvicultural treatments quantified.
- Science-based advice is made 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 are provided with information to assess the achievement of ecologically sustainable forest management, and as a benchmark for developing adaptive management practices.

Fire Management

- Fire management practices are based on a sound scientific understanding of fire behaviour and the effects of fire on ecosystems.
- Decision support systems are provided to fire managers for implementing new approaches to fire management that integrate biodiversity conservation and community protection objectives.
- Departmental personnel involved in fire suppression are provided with reliable fire behaviour guides and are able to recognize potentially hazardous situations on the fire-ground.

Vegetation Health Service

- 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 research are made known to representatives of Output Purchaser Divisions (primarily Nature Conservation and Sustainable Forest Management), and to District, Regional and Forest Product Commission staff as appropriate.
- Findings likely to stimulate a change in planning procedures or policy are presented to senior staff in seminars and field days. Where appropriate, presentations may also be made to the Conservation Commission at the request of the Executive Director of DCLM.
- New techniques are presented to DCLM field personnel in training sessions, workshops and field days, and to and FPC personnel as appropriate to the circumstances.
- Results are published in recognized national and international scientific journals.
- Scientific and technical staff collaborate with managers to develop decision support systems that can be linked to corporate databases, and made available widely throughout the Department by means of web-based systems.
- Findings from research are used as a basis for revising 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 DCLM officers (e.g. 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.

Partners/Collaborators

As opportunities arise, we seek to link with external research and development related to ESFM. This is

achieved through joint funding proposals with other institutions (e.g. Universities, Department of Agriculture, CSIRO), and through participation in Co-operative Research Centres including the CRC for Carbon Accounting. Where the expertise for particular projects is lacking or where there are significant advantages in collaborative projects, specific DCLM funded projects will be developed with other agencies.

Staff

Name	Position	Location	FTE
I Abbott	Senior Principal Research Scientist	Kensington	0.15
T Burbidge	Senior Technical Officer	Kensington	1.0
Vacant	Vacancy ex N D'Souza	Kensington	0.4
M Stukely	Research Scientist	Kensington	0.5
J Webster	Technical Officer	Kensington	0.6
A Wills	Technical Officer	Kensington	1.0
J Kinal	Senior Technical Officer	Dwellingup	1.0
D Mickle	Technical Officer	Dwellingup	0.5
K Whitford	Senior Technical Officer	Dwellingup	1.0
J Farr	Research Scientist	Manjimup	1.0
G Liddelow	Senior Technical Officer	Manjimup	0.9
L McCaw	Principal Research Scientist	Manjimup	0.95
J Neal	Senior Technical Officer	Manjimup	0.8
R Robinson	Research Scientist	Manjimup	1.0
J Rooney	Technical Officer	Manjimup	1.0
R Smith	Senior Technical Officer	Manjimup	1.0
V Tunsell	Clerical Officer	Manjimup	1.0
C Vellios	Senior Technical Officer	Manjimup	1.0
B Ward	Senior Technical Officer	Manjimup	0.9
C Ward	Senior Technical Officer	Manjimup	1.0
A Wayne	Research Scientist	Manjimup	0.9
Total			**17.6**

Program 2 Environmental Services

Output Purchasers Nature Conservation
Sustainable Forest Management
Forest Products Commission

Program Leader Dr Margaret Byrne, Kensington

Description

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

The Program has 2 broad areas of activity, sub-programs: Genetic Resources, and Tree Crops.

Genetic Resources

The Genetic Resources sub-program provides a range of genetic and breeding research for revegetation programs using tree species in farm forestry, plantation and native forest environments. Revegetation 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 utilization of native species. Many species with potential for revegetation 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 characteristics that influence the hydrological effectiveness and commercial traits will increase the environmental benefits and productivity of revegetation 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 DCLM provides some tree breeding and genetic marker technology services to FPC as required. DCLM 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 maximize diversity in crossing programs and monitoring of gene flow in seed orchards. This sub-program 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.

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 Jarrah germplasm will facilitate rehabilitation of dieback affected sites in the Jarrah forest.

Tree Crops

The Tree Crop component of the program covers the areas of site evaluation systems , establishment and stand management, and the management of pests and diseases in revegetation and plantation systems.

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

Predictions of the nutrient requirements and stand densities required to optimise 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 location of revegetation on farms to optimise water use and profitability and demonstrate the effectiveness of fast-growing strips to 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 revegetation will not occur unless there are commercial drivers (as seen with *Eucalyptus globulus*). The development of an oil eucalypt industry (Revegetation Systems Program) and assessment of 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

Objectives

Genetic Resources

Optimise the effectiveness of revegetation, farm forestry and plantations through:

- Selection and breeding of superior tree genotypes for important traits such as water use, salt tolerance, growth, form, wood density, and oil production.
- Use of genetic markers to validate breeding programs, determine 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 and revegetation programs.
- Selection of dieback resistant lines of Jarrah and establishment of seed orchards to provide improved dieback resistant germplasm.

Tree Crop

To develop systems which allow the integration of trees into farmland and farming systems in the <600 mm rainfall zone by:

- Determining the best distribution of trees to maximize their water use and thus salinity control, and systems where short rotations of trees are alternated with agriculture.
- Investigating the value of multi-species ('biodiversity') plantings for carbon sequestration and biodiversity enhancement.
- Developing practical management strategies which optimise the profitability and sustainability of farmland revegetation.

- 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 impact of revegetation on soil carbon content.
- Developing strategies which take into account present and future risks to farm forestry from pests and diseases.

To maximize the wood production from high rainfall state owned and managed plantations by:

- Devising practical management strategies (fertilizer programs, safe stand density limits) that optimise the profitability and sustainability of *Eucalyptus globulus* plantations established on farmland.
- Devising strategies that 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 DCLM.
- 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.

Significance and Benefits

Genetic Resources

- Significant gains in the capacity of trees to utilize water, and in commercial traits, can be made through tree breeding and improvement programs. The development and utilization 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 maximize the genetic gains to be made.
- Knowledge of genetic resources enables efficient development of species for commercial farm forestry and revegation programs for salinity control. The utilization of species complexes requires the identification of genetic entities and their relationships before selection and breeding is 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

- Improved performance (growth, survival) of tree crops in the < 600 mm rainfall zone will lead to increased adoption of tree cropping and revegetation outside traditional plantation areas in southern WA.
- Demonstration of successful farm forestry systems will encourage investment in this area, and make a significant impact on solving farmland degradation caused by salinity and wind erosion in the < 600 mm rainfall zone.
- Provision of improved silvicultural management systems for softwood and hardwood plantations in the > 600 mm rainfall zone will ensure that plantations perform at their potential. Expenditure on fertilization will be based on response data on a site by site basis and ensure that silvicultural activities are both timely and economic.

Targets/expected results

- Improved genotypes that maximize productivity from plantations and tree crops.
- Identification of genetic diversity in species developed for both commercial farm forestry and revegetation for environmental benefits.
- Validation of breeding and crossing programs, and seed orchard performance.
- Productive 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 and revegetation species for the zone with less than 600mm rainfall (e.g. a range of eucalypts for sawlog production and for effective hydrological control.).
- Accurate site selection system for Maritime pine in the medium rainfall zone.
- Practical and effective carbon accounting systems for tree crops and plantations.
- Revegetation layouts and arrangements that provide control of ground water.

Tasks (SPPs), Activities, Milestones, Outputs

SPP No	Project Title	Key Activities	Milestones	Outputs
Genetic Resources				
93/0126	Genetic variation in quantitative traits of exotic and endemic plantation and rehabilitation species.	Write up *E.viminalis* trials and Oil mallee (*E. polybractea* & *E. horistes*) paper. Analyse orchard data for *E. loxophleba*, *angustissima* and *oleosa* trials and provide culling plans. Analyse *E. globulus* trial data. Selection of *E. sideroxylon*.	**12/02** *E. globulus* data analysis completed. **06/03** 1. Paper on *E. viminalis* written. 2. Oil mallee data analysis completed. 3. Selection of trees completed.	Publication of journal papers. Selection of best trees in orchards and associated culling plans. Selection of trees for oil mallee clonal orchard/seed collection. Selection Index for best individual *E. globulus* for cloning.
93/0112	Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*.	**a.** Establish clonal DRJ (Dieback Resistant Jarrah) seed orchard.	**a. 09/02** 1. Finalize stage 2 design of seed orchard; site prep; pegging. 2. Plant second stage of seed orchard. **03/03** Monitor survival of orchard trees. **06/03** 1. Production of DRJ clones for 2003 planting. 2. Write and submit report to NHT.	**a.** Production seed orchard of DRJ. Report to NHT.
		b. 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).	**b. 09/02** Finalize trial designs and set up (re-pot). **03/03** Complete inoculation of trials. **06/03** 1. Trials measured. 2. Data analysis in progress; DRJ seedlings for propagation selected. 3. Establish linkage to SPP 93/126 – field trial measurement.	**b.** Report on improved DRJ selection methods. DRJ provided to Alcoa for propagation.
		c. Monitor survival of field DRJ validation trials (clones) and test dead plants for *P. cinnamomi* infection.	**c. 06/03** 1. Survival and growth monitored. 2. Data analysed; reject DRJ lines culled.	**c.** DRJ clonal lines that pass validation test - for use in seed orchards.
94/0006	Dieback resistant jarrah (DRJ) establishment in operational forest rehabilitation sites	Mapping and survival assessment of DRJ plantings in forest.	**6/03** 1. DRJ plantings assessed & mapped. 2. Plan for further establishment trials.	Progress report.
95/0014	Vegetative propagation by grafting of dieback resistant jarrah for seed orchard establishment.	Develop grafting techniques for use with dieback resistant jarrah (DRJ).	**12/02** Produce seedlings for Trial 2 rootstocks. **3/03** Grafting trials using DRJ clones as	Report to NHT. Technical report on technique for grafting jarrah (for application to DRJ lines that are difficult

			scions. **6/03** Analysis of data and write and submit report to NHT.	to propagate by tissue-culture) for seed orchard establishment.
98/0007	Genetics and molecular biology of tree species.	1. Investigate genetic patterns in *Acacia microbotrya*. 2. Investigate genetic patterns in *A. saligna*. 3. Determine genetic diversity in *Pinus brutia* stands in Australia. 4. Establish regional differentiation in *E. cladocalyx*. 5. Develop microsatellite markers in *P. pinaster*.	**09/02** Journal paper on genetic differentiation between taxa in the *E. angustissima* complex written. **12/02** Sequence 100 clones from *P. pinaster* genomic library. **03/03** 1. Journal paper on provenance effects in *E. occidentalis* written. 2. Analysis of genetic patterns in *A. microbotrya* completed. **06/03** Analysis of genetic patterns in *A. saligna* completed.	Journal paper on genetic differentiation in the *E. angustissima* complex. Journal paper on provenance effects in *E. occidentalis*. Report on genetic patterns in *A. microbotrya*. Report on genetic patterns in *A. saligna*.
Tree Crop				
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.	**12/02** Refined site quality model following re-measurements of youngest plots. **03/03** Refined yield prediction.	Refined site quality model for FPC. Refined yield prediction for FPC. Scientific paper(s) on site quality assessment & yield prediction.
TBA	Biomass and carbon studies	Refine *P. pinaster* growth model in *FarmWood* (include site quality, belt simulation & improve thinning simulation). Evaluate potential for carbon sequestration studies of sawlog plantations for water resource catchments. Service BP project.	**03/03** Growth curves for belt plantings in *FarmWood* completed. **06/03** 1. Complete investigation of methods for simulating thinning in *FarmWood*. 2. Complete assessment of resource of sawlog plantations on catchments for C sequestration studies.	Refined and improved *FarmWood* model. Scientific paper on stand - and region-level C sequestration prediction in *P. pinaster*. Report on potential for C sequestration studies in sawlog plantations on catchments. BP project provided with technical advice & support.
TBA	CRC Greenhouse Accounting studies	Evaluate root sampling strategies Study effect of N fertilizer on biomass portioning in *P. radiata*. Decay of harvest residues study	**12/02** 1. Completed analysis N fertilizer experiment. 2. Commenced sampling of roots and above-ground debris in 'decay of harvest residues study'. **06/03** Completed analyses and simulations for comparison of root sampling strategies.	Scientific paper on N fertilizer study.
2000/18	Early rotation	Continue monitoring	**09/02**	Publication of results

	nutrition and silviculture of pines on ex-farmland.	existing experiments. Initiate work to investigate the influence of nitrogen on growth and form of *P. pinaster*.	Re-measure 2 form pruning experiments. **06/03** Initiate widespread form assessment of *P. pinaster* plantations.	from initial NPK interaction experiments in Australian Forestry.
2000/16	Water use and nutrition studies of *P. pinaster* in the medium rainfall zone	Measure soil water, tree water status and growth on 3 sites across the MRZ. Commence data analysis for *P. pinaster* and continue monitoring the *P. radiata* site. Evaluate data requirements for model development.	**06/02** Complete 5th yr of measurements. **03/03** Complete preliminary data analysis. **06/03** Draft MS of first phase of study.	Journal paper on improving plantation and farm forestry productivity.
93/0152	Use of heat pulse methodology to measure sap flow in pine spp.	Collate data. Calculate sapflow and analyse data.	**6/03** 1. Complete HPV calculations, scale to stand basis. 2. 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 minimization strategy. Paper on the linkage between leaf area and growth
TBA	Phase farming with trees - Ultra-short agroforestry rotations for salinity control.	Continue field study.	**09/02** Remeasure field trials. **12/02** Write paper from scoping study. **06/03** Paper describing water relations with depth under young plantations.	Papers published on Scoping study and tree water use and soil water data. Conference paper for National Soils conference.
TBA	Putting Trees in Their Place - optimizing tree placement across the landscape.	Establish broadscale planting trials install measurement equipment. Establish retrospective water use studies in pine and oil mallee plantings on at least 3 sites.	**06/03** Continue measurements of trees and water use at trial sites.	Information on control of recharge at a landscape scale using broadscale tree planting.
93/0123	Site evaluation for *E. globulus*	Complete MS.	**06/03** Papers submitted to Forest Ecology and Management on 1. Climatic effects. 2. Soil effects. Conference presentation of same.	Published papers 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 MS.	**06/03** Paper submitted.	Publish paper on the performance of *E. globulus* Esperance sandplain.
TBA	Subsoil constraints to tree water use by *E. globulus*.	Data analysis for Brinsdens & Rocky Gully (Soil profile, soil moisture, tree water potentials, leaf area, growth, sap flow, hydrogen/deuterium isotope ratios,)	**06/03** 1. Collate and calculate HPV data. **06/03** 2. MS on Examples of soil and climatic conditions and their effects on *Eucalyptus globulus* prepared. 3. Convert sapflow data to stand basis, liaise with other	3 papers on effect of soil and environmental factors on the water use and growth of *E. globulus* in southern WA.

			authors to update soil moisture calculations.	
TBA	Effect of plantation and tree crop establishment on soil carbon contents.	Comparison of soil carbon under trees and adjacent pasture	**09/02** Measurement of paired plots under 6 mallee belts and 6 Eucalypt plantations. **12/02** Paper for 'Future Soils' Conference written. **06/03** Journal paper on soil carbon written.	One journal paper and one conference paper on effects of revegetation on soil carbon contents and soil organic matter quality.
93/0128	Early/mid rotation nutrition of *E. globulus* in south west WA	Analyse data from mid rotation nutrition experiments. Examine second rotation establishment nutrition. Examine trace element/growth relationship on acid-peat soils.	**6/03** Complete data analysis. **12/03** Paper on mid-rotation nutrition written. **6/03** 1. Update technical information for plantation managers. 2. Assess growth and survival in 2R fertilizer trial.	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. Write paper	**12/02** 1. Complete data analysis. 2. Paper on manganese deficiency in *E. globulus* written.	Report on manganese deficiency for plantation managers. Journal paper.
93/0130	Drought deaths in *E. globulus* on the Darling Scarp	Complete report and publish.	**06/03** Report published	Published report on factors influencing drought in *E. globulus*.
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. Modeling of water use and growth data.	**06/03** 1. Continue field measurements 2. Provide data to CSIRO modellers.	Report to funding organizations. 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.	**06/03** Comense analysis of data.	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 MSS	**6/03** Complete and submit 2 MSS.	Two papers on the use of foliar analysis in *P. radiata*. Revised management prescriptions for use of foliar analysis.
93/0140	Mid rotation response to thinning and fertilization by *P. radiata* and *P. pinaster*.	Write papers. Continue monitoring of existing long-term experiments. Conduct large stem analysis and biomass sampling to conclude field measurements of one experiment	**6/03** Complete and submit 2 MSS.	Papers on the silvicultural and water management of plantations in 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.	Prepare MS.	**06/03** Conference paper written.	Conference paper on weed control in second rotation pines.
2000/17	Comparative use of mineral fertilizers and biosolids on the nutrition of pines on the coastal sand plain.	Continue growth and nutrient measurements. Final data analysis.	**09/02** Continue growth, water and nutrient measurements. **12/02** Final data analysis and completion of report.	Report to Water Corporation on the efficacy of biosolids as a fertilizer alternative. Report on the assessment of the likely risk of contamination of the local groundwater resources from using such material in pine plantations. Three Conference papers on biosolids use in pines.

Outcomes

Genetic Resources

- Increased productivity of revegetation, 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 and environmental related revegetation.
- Rehabilitation of dieback affected forest sites with dieback resistant jarrah seed.

Tree Crop

- Broad scale revegetation in the agricultural area based on improved prescriptions for establishment and management of farmland revegetation.
- Sustainable and profitable plantations in the high rainfall areas based on improved prescriptions for establishment and subsequent management.

Adoption strategy

Genetic Resources

- Direct transfer of research results and breeding material to Revegetation Systems Program for incorporation into development strategies for native species.
- Information passed to the public through the Revegetation Systems 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 DCLM operational staff through reports and workshops.
- Publication of research results in scientific papers in journals and at conferences.

Tree Crop

- Preparation and distribution of management prescriptions (via DCLM/DOA Farm Forestry Advisory Service Tree Note).
- Management reports elaborating on findings.
- Field days/seminars for managers with results, training and feedback.
- Scientific papers to put results in the public arena.
- Popular press articles.
- Information on DCLM Internet site.
- Continual advice to FPC plantation managers and DCLM operations staff on informal basis.
- Manuals covering the diagnosis and correction of nutrient deficiencies.

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, DOA, CSIRO) and private industry. Examples of current collaborations in this area are:

- Examining the ecophysiology of blue gum with CSIRO.
- 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, DOA 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, Griffin Energy)

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

Staff

Staff	Position	Location	FTE
M. Byrne	Principal Research Scientist	Kensington	0.5
B. Macdonald	Technical Officer	Kensington	0.5
M. Stukely	Research Scientist	Kensington	0.5
R. Mazanec	Research Scientist	Kensington	1.0
J. Kinal	Acting Research Scientist	Dwellinup	0.5
D. Mickle	Technical Officer	Dwellinup	0.5
J. McGrath	Senior Principal Research Scientist and Group Manager	Kensington	0.2
R. Harper	Senior Research Scientist	Kensington	1.0
S. McArthur	Technical Officer	Kensington	1.0
L. Wong	Senior Technical Officer	Kensington	1.0
N. Robinson	Research Scientist	Kensington	1.0
A. Stilwell	Technical Officer	Kensington	1.0
R. Archibald	Technical Officer	Kensington	1.0
N. D'Souza	Technical Officer	Kensington	0.6
B. Maslin	Senior Principal Research Scientist	Kensington	0.2
I. Dumbrell	Research Scientist	Busselton	1.0
K. Mungham	Senior Technical Officer	Busselton	1.0
B. Copeland	Senior Technical Officer	Busselton	0.6
P. Ritson	Senior Research Scientist	Kensington	1.0
B. Brand	Technical Officer	Kensington	1.0
S. Sochacki	Senior Technical Officer	Kensington	1.0
Total			**16.1**

Program 3 Revegetation Systems

Output Purchasers Nature Conservation Division
Forest Products Commission
Oil Mallee Company

Program Leader John Bartle, Kensington

Description

The Revegetation Systems Program aims to develop the technologies and tree crop industries that will change the environmentally destructive water balance of wheatbelt agriculture. Unless higher water use can be achieved it will not be possible to protect the remaining natural biodiversity of wheatbelt valley floor and riverine ecosystems. Higher water use is most effectively achieved by revegetation with perennials. However, the scale on which revegetation must be undertaken, even as only a component of an integrated set of salinity control treatments, is so large that volunteer, non-commercial tree planting, commonly associated with landcare and natural heritage programs, is not a feasible option. Non-commercial revegetation on the necessary scale would render most farm businesses insolvent, even if they did not have to pay for implementation or be obliged to maintain the revegetated area. Hence this Program's goal is to create new commercial tree crops and to increase the adoption of existing tree crops to make large-scale

wheatbelt revegetation feasible. It currently consists of 3 main sub-programs.

1. Mallee sub-program: commenced in the early 1990s and is based on native wheatbelt mallee species. It has developed the foundation for a large scale industry in the wheatbelt of WA. The industry has developed its own commercial structure under the control of growers. DCLM has a unique position of leadership in technical and environmental aspects for the industry and is its major technical services provider. The industry has planted 23 million seedlings and created a substantial resource. A commercial feasibility investigation has shown that 'integrated processing' of mallee feedstocks would be commercially viable. Integrated processing would concurrently produce eucalyptus oil, higher value wood products from the wood fraction of mallee (initially activated carbon) and electricity generated from residues and process heat. A demonstration scale processing plant is under construction at Narrogin at a cost of $6 M. If this demonstration plant is successful there is potential for about 9 full scale plants each requiring some 10 000 ha of mallee.

2. Search sub-program: the example of mallee indicates that the concept of very short rotation native shrubs being used as crops for production of wood and other products merits further investigation. Indeed there may be many woody native species, and many products that could be derived from them, that await serious investigation and development. In 1999 this prospect gave rise to a major Natural Heritage Trust project (Developing multiple purpose species for large scale revegetation, commonly called the Search Project, NHT 973849) that aims to systematically screen a wide range of native species for their biological potential as crops, and for their potential for products able to compete in large volume markets. This project has subsequently been complemented by others sponsored by the Joint Venture Agroforestry Program (JVAP), and the Co-operative Research Centre for Plant Based Management of Dryland Salinity.

3. Adoption sub-program: aims to increase the adoption of long rotation tree crops, through the use of conventional timber trees in mainstream agricultural practice. It is focused on farmland in the medium rainfall (450 to 650 mm/year) zone where salinity and other forms of land degradation are also acute and where extensive adoption of tree crops is essential to improve the potential for biodiversity protection. Tree crops that have been evaluated for their economic viability and their potential for integration in agricultural systems include pine for softwood, bluegum for pulpwood, selected eucalypts and a suite of native woodland eucalypts for high-grade timber. Research over 15 years has shown that it is feasible to produce sawlogs within 20 years from several eucalypt species. 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. The sub-program promotes the adoption of long rotation tree crops by stimulating interest, improving understanding and co-ordinating the activity of the grass roots growers, the wider community and investors. The potential for inclusion of native species needs to be defined.

There is an urgent need for improved management of private native forest. There are some 200 000 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. The Adoption sub-program has reviewed the legal, commercial and environmental issues and defined guidelines and practices for sustainable management of private native forest, including timber production.

Finally the Adoption sub-program has had a major role in training and education. It utilizes the extensive knowledge and experience of the group to develop, co-ordinate and consult on a range of training and education programs related especially to integrated farm forestry.

Objectives

Mallee sub-program

- Conduct reconnaissance, clarify the genetic identity and evaluate performance of prospective native wheatbelt oil mallee species.
- Select superior oil mallee germplasm from wild populations, test and improve genetic performance and manage seed production of the 6 major 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 mallee and other short rotation tree crops.
- Develop new large volume uses for eucalyptus oil.

Search sub-program

- Conduct systematic selection of new species with commercial potential.
- Create a focus for commercial development of best bet commercial prospects by instigating large scale planting.

Adoption sub-program

- Favour the development of native species for sawlog production systems
- Increase the adoption of 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 eucalypt sawlog industries in the medium rainfall zone based as far as possible on native species.
- 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

Mallee sub-program

The salinization process in the south-west agricultural area is pervasive and destructive. It severely impacts on all commercial, conservation and social activities along 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 essential if extensive salinity control is to be achieved. The mallee sub-program 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 feasible. It is a co-ordinated whole industry development that combines public investment with farmer enterprise to achieve environmental, social and commercial benefits. The R&D supported by the public investment component is targeted at critical barriers to creating a commercially viable industry.

Search sub-program

The sub-program aims to build on the oil mallee project by diversifying the native species, multiple benefit, short rotation 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 subprogram

A eucalypt sawlog industry would complement and greatly expand the potential for tree crop industries in the intermediate rainfall zone (drier than bluegum but wetter than the wheatbelt). There is potential to incorporate a significant proportion of native species. It would complement maritime pine by extending tree planting 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.

There are some 200 000 ha of native forest on farms in the south-west that is commonly in poor condition and degrading rapidly. It is a sadly neglected conservation and commercial resource. Better recognition of the commercial and environmental value of these forests will motivate landowners to improve their management and therefore increase the biodiversity protection value of these ecosystems as well as generating 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

- Provision of 90% genetically improved seed of oil mallees.
- Optimal harvest regimes and biomass yields for oil mallees.
- Effective low cost operational prototype mallee harvester.
- Increased adoption by farmers of tree crop planting integrated in farm management.
- Guidelines for sustainable management of tree crops for landholders.

Tasks (SPPs), Activities, Milestones, Outputs

SPP No	Project Title	Key Activities	Milestones	Outputs
Mallee industry development *(This project is conducted in partner-ship with the Oil Mallee Company and the Oil Mallee Association as 'industry' joint purchaser)*				
	Gerplasm selection, breeding and propagation for the emerging mallee industry.	Locate, test, voucher and collect seed from elite (high oil) parents in wild. Conduct progeny trials. Establish and manage OPSSOs. Produce seed. Develop clonal propagation Investigate germination inhibition in seedling propagation.	**09/02** Specify and collect seed from required number of elite wild trees. Collect seed from all OPSSO. **12/02** Induct germination testing results into mallee seed supply. **03/03** Determine breeding values and cull P98 Oleosa progeny trials. Finalize industry seed production plan with mallee industry. **06/03** Commence clonal propagation trials.	Provision of P03 oil mallee seed using all orchard seed for the 5 major species. Comprehensive industry breeding plan. Prescription for germination enhancement of mallee seed.
	Planting density	Investigate appropriate planting spacin.g	**03/03** Monitor trial sites.	Decision on need for further trials in P03.
	Harvest regime Harvest and handling systems	Tend trials on biomass productivity effects of combinations of season and frequency of harvest. Design and develop large volume harvest and handling systems.	**12/02** complete field work on the Kalannie trial (D Wildy PhD Study). Complete establishment of 25 season x frequency trials covering all species x sites. **03/03** 1. Raise c. $3 M in capital to complete operational prototype harvester and handling systems. 2. Finalize harvester development plan.	Terminating Report to FFP. Report detailing development plan for operational prototype harvest and handling systems.
Search sub-program				
	Demonstration planting	Establish demo trials of potential large scale commercial species.	**06/03** Conclude project.	Terminating Report.
	Search process	Finalize selection based on biological selection. Conduct product testing of selected species for prospective products.	**06/03** Finalize project.	Terminating Report
	CRC Search	Induct CRC sponsored project on termination of NHT Search. Participate in National Florasearch Project. Participate in National germplasm testing project.	**03/03** Finalize proposal. **06/03** 1. Conclude selection of WA target development species. 2. Conclude germplasm testing plan.	Agreed state development targets. Share of national funding of Florasearch. A national germplasm testing plan.
Adoption sub-program				
	Eucalypt Sawlog Industry Development	Review potential for use of native species. Facilitate collaboration between potential participants in eucalypt sawlog industry. Monitor growth rates of existing trials in South West. Assist interested landowners to plan,	**03/03** Conclude plans with W&RC & FPC for planting program in Water Recovery Catchments. **06/03** Trials measured. **12/02** Landowners interested in	500 ha of eucalypts for sawlogs established in Recovery Catchments. Updated timber yield for eucalypt sawlog/woodland

		implement & manage eucalypts for sawlogs. Conduct farm & industry scale economic analysis.	eucalypts for sawlogs assisted. Review all native woodland eucalypt trials.	species. Good quality plantings and demonstration sites.
	Private Native Forest Project	Implement demonstrations of sustainable management of private native forest in the karri, jarrah and wandoo zones.	**09/02** Prepare guide-lines on managing private native forest. **06/03** Complete demonstration private native forests in all native forest types.	Handbook on with guidelines on managing private native forest. Managed demonstration sites in all native forest types.
	Master Tree Growers Program	Assist Co-ordinator to plan and deliver Master Tree Grower Courses, to landowners practicing farm forestry. Work with State Co-ordinator to run follow-up Courses, on tree measurement to hone growers skills and collect local growth data.	**03/03** Run Master Tree Grower Program in the two districts. **06/03** Remeasure 20 plots established during 2000 with participating Master Tree Growers.	2 courses completed and documented. New tree growth data collection project in place. New grower networks established.
	Farm Forestry Courses and Industry Extension	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.	**03/03** Short Introductory Courses in Farm Forestry run at various locations. **06/03** Participate at and provide input to key field days and seminars.	Farm advisers who have completed Introductory Course and connect to farm forestry networks, information and services. New grower networks established. Investment in and adoption of farm forestry increased.

Outcomes

Mallee sub-program

- A major new industry based on oil mallee crops available to 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 a feasible objective.

Search sub-program

- Three new best bet species (or groups of species) identified, including at least one sprouter 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 sub-program

- 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.
- Native woodland eucalypts become a significant part of timber crop establishment.
- The new timber resource on farmland give rise new regional economic development through processing industries.
- Farmers recognize 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 the extensive privately owned native forests in WA.
- 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

Mallee and search sub-programs

- 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 sub-program

- Build partnerships with the DCLM biodiversity recovery catchment managers and Water & Rivers Commission water recovery catchment managers to conduct tree crop planning and implementation activities.
- Foster a co-operative 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 of tree crops, especially native eucalypts.
- 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 Contract.
- 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, i.e. 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	Position	Location	FTE
J Bartle	Senior Principal Research Scientist	Kensington	1.0
G Brennan	Research Scientist	Bunbury	1.0
W Edgecombe	Senior Technical Officer	Kensington	1.0
R Giles	Senior Technical Officer	Kensington	1.0
P Ryan	Senior Technical Officer	Geraldton	1.0
D Cooper	Technical Officer	Kensington	1.0
J Carslake	Technical Officer	Kensington	1.0
D Huxtable	Technical Officer	Kensington	1.0
R Moore	Senior Research Scientist	Busselton	1.0
B Hingston	Senior Technical Officer	Busselton	1.0
M Power	Revegetation Officer	Albany	1.0
C Robb	Revegetation Officer	Katanning	1.0
P LeGear	Revegetation Officer	Moora	1.0
V Mischker	Revegetation Officer	Esperance	1.0
Total			**14.0**