ANNUAL RESEARCH ACTIVITY REPORT

June 2002 – June 2003

Science Division

Discovering the nature of WA
http://www.naturebase.net/science/science.html

Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

FOREWORD

This report provides a concise summary of the research activities of Science Division of the Department of Conservation and Land Management for the fiscal year 2002 / 2003.

Over this period staff produced more than 240 publications, were active on 130 research projects, assisted or supervised 62 mostly PhD students and developed some 51 significant partnerships with external agencies. In addition, they provided advice, gave presentations and assisted with thousands of enquiries from other departmental staff, colleagues and the broader community.

Progress achieved in the performance of core functions is also documented. Our research activities included all nine administrative regions of the State as recognized by the Department.

DCLM Region	No. Projects
South West	48
Wheatbelt	45
Warren	44
Swan	43
South Coast	42
Midwest	38
Pilbara	20
Goldfields	15
Kimberley	10

In terms of the 26 bioregions included in Western Australia, staff were involved actively in research projects in each one. The distribution of effort was as follows:

No. Projects	Bioregions
51-60	Jarrah Forest
41-50	Avon Wheatbelt
31-40	Swan Coastal Plain, Warren, Esperance Plains
21-30	Geraldton Sandplains, Mallee
11-20	Pilbara, Murchison, Gascoyne, Carnarvon, Coolgardie

If more information is required on any of the topics listed, I encourage you to contact the relevant project team leader or refer to the Division's Business Plan and Operations Plan accessible at http://www.naturebase.net/science/science.html

Users of this document should contact me at neilb@calm.wa.gov.au if they have any suggestions for improving the presentation of subsequent reports.

Dr Neil Burrows
Director, Science Division

29 August 2003

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VISION

We envisage a society where scientific enquiry is highly respected and forms an objective basis for environmental decision making and policy development. We strive to provide excellence in science and technology based on internationally recognized best practice. We operate research centres that foster, promote and reward creativity and innovation.

FOCUS AND PURPOSE

Provision of up-to-date and scientifically sound information to uphold effective conservation of biodiversity and sustainable natural resource management in Western Australia.

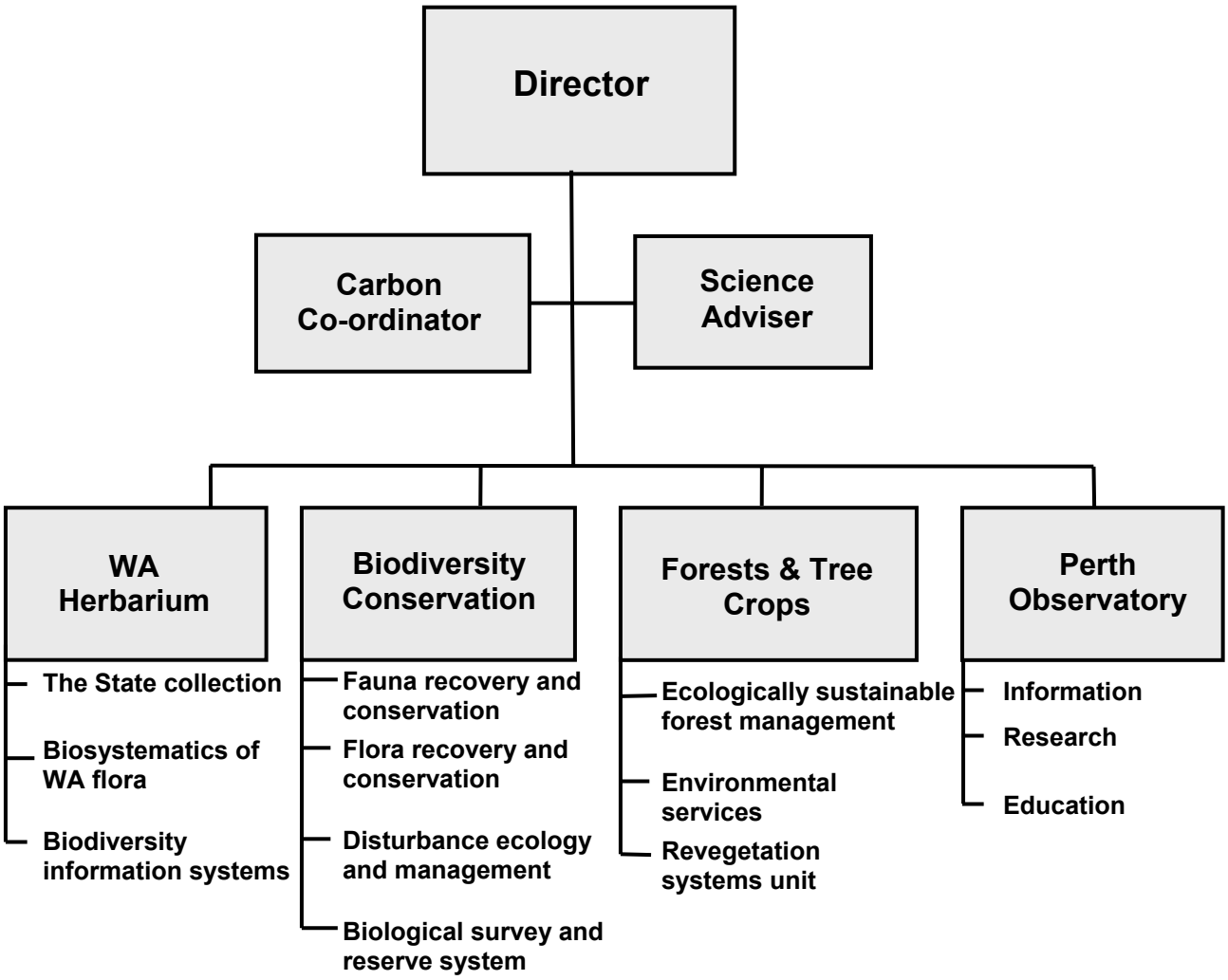
ROLE

To achieve its Mission, Science Division has the following broad objectives:

- To provide a scientifically objective and independent source of reliable knowledge and understanding about conserving species and ecological communities in Western Australia, managing the public lands and waters entrusted to DCLM, and carrying out DCLM 's other legislative responsibilities.
- To ensure that Science Division is responsive to the needs of policy makers and output purchasers in DCLM and FPC by bringing science to bear on the solution of the State's most pressing problems relating to conservation and land management.
- To advise DCLM and FPC on sustainable resource development opportunities and to promote the conservation of biological resources through their sustainable utilization
- To communicate and transfer to managers in DCLM and FPC knowledge, information and other insights obtained through scientific investigation in Western Australia and elsewhere.
- To attain a worldwide reputation for excellence in science by publishing knowledge obtained through scientific research in the premier national and international scientific journals and through electronic means.
- To contribute, as an integrated part of DCLM, to meeting the need for knowledge on conservation and land management matters by the public of Western Australia.

SERVICE DELIVERY STRUCTURE

SCIENCE DIVISION



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CURRENT COLLABORATION WITH ACADEMIA

(Student Projects)

Further details on progress are provided on pp 133

Biological component

DCLM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Abbott, Ian	Tim Simmons	How birds may be used as a bio-indicator of ecosystem health in jarrah forest at various stages/disturbance states	PhD	2001-04	Prof J Fox and Adj Prof S Davies	Curtin University
Abbott, Ian	Dean Paini	The impact of the European honey bee on Australian native bees	PhD	1998-03	Prof W Bailey and Dr D Roberts	University of Western Australia
Abbott, Ian	Matt Williams	Conservation and ecology of threatened butterflies	PhD	1999-08 (0.4 FTE)	Prof B Lamont	Curtin University
Abbott, Ian	Brian Giltay	The relationship of soil fauna to land-use and disturbance on the Swan Coastal Plain	Honours	2003	Prof L Abbott	University of Western Australia
Abbott, Ian	Tristan Graham	Effect of phosphite application on beetle species diversity in Waychinicup	Honours	2003	Dr M Garkakalis	Murdoch University
Angus, John	Maggie Lilith	Benefits arising from the exclusion of domestic cats through local government by-laws	PhD	2003-07	Dr M Calver and Dr M Garkakalis	Murdoch University
Bartle, John	Robyn Bell	Germination physiology of 3 oil mallee species	Masters		Prof S Shea	Notre Dame University
Burrows, Neil	Adam Leavesley	Arid zone fire ecology especially indigenous use of fire			In preparation	
Burrows, Neil	Joyce Eades	Immunocontraception to control feral cats	PhD	2000-03	Dr C James	Murdoch University
Burrows, Neil	Peter Adams	Exchange of parasites and diseases between native mammals and feral cats	PhD	2000-03	Prof A Thompson	Murdoch University
Burrows, Neil	Olivier Chavand	The origin and phylogeographic structure of the feral cat population in Western Australia	PhD	2000-03	Prof A Thompson	Murdoch University
Burrows, Neil	Adrian Wayne	Ecology and habitat requirements of the western ringtail possum	PhD	2001-04	Dr M Calver	Australian National University
Byrne, Margaret	Nic George	Development of *Acacia saligna* for revegetation	PhD		Dr G Yan	University of Western Australia

DCLM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Byrne, Margaret	Dean Nicolle	Taxonomic revision of *Eucalyptus* series *Subulatae*	PhD		Dr M Whalen	Flinders University
Byrne, Margaret	Ryonen Butcher	Taxonomy and systematics of the genus *Synaphea*	PhD		Dr J Chappill	University of Western Australia
Byrne, Margaret	Cate Tauss	Phylogeny, phylogeography and conservation of *Reedia spathacea*	MSc		Dr J Chappill	University of Western Australia
Byrne, Margaret	Lynley Stone	Development of *Conospermum* for the cut-flower industry	PhD		Prof J McComb	Murdoch University
Byrne, Margaret	Esther Walker	Investigating the possible hybrid status of 2 Declared Rare Flora in the Albany region	Honours		Prof J McComb	Murdoch University
Chapman, Alex	Amanda Spooner	Systematics and Conservation of Lambertia Sm. (Proteaceae)	MSc		Dr K Lemson	Edith Cowan University
Coates, Dave	Christopher Gage	Genetic diversity, demography and viability of fragmented populations of *Eremaea pauciflora*	Honours PhD	2002 2003	Prof J McComb	Murdoch University
Coates, Dave	Cathy Waters	Developing seed provenance zones for Australian native grasses	PhD		Dr J Virgona	Charles Sturt University, NSW
de Tores, Paul	Matt Hayward.	The ecology of the quokka, *Setonix brachyurus*, in the Northern jarrah forest of south-west Western Australia	PhD	2001-03	Dr P Banks	University of New South Wales
de Tores, Paul	Erika Alacs	Genetic variation in the quokka, *Setonix brachyurus*, using microsatellites and amplified fragment length polymorphism (AFLP)	Honours	2001-03	Dr P Spencer	Murdoch University
Dumbrell, Ian & McCaw, Lachie	Stefan Eberhard	Environmental hydrogeology and stgofauna in Jewel Cave karst system	PhD	2002-05	Dr A Storey	UWA
Friend, Tony	Julie Whelan	Effect of Phytophthora infection on diet of mycophagous mammals	Honours	2003	Dr M Garkakalis	Murdoch University
Gibson, Neil	Gary Odgen	Wetland tree recruitment in inland wetlands of south-west Western Australia	PhD	Deferred	Dr R Froend	Edith Cowan University
Halse, Stuart	Winston Kay	Population ecology of estuarine crocodiles, *Crocodylus porosus*, in the Kimberley region of WA	PhD	2000-04	Prof G Grigg and A/Prof H McCallum	University of Queensland
Halse, Stuart	Erin Lowe	Examining tolerance of diatoms & macroinvertebrates to salinity and acidity, mostly on Swan Coastal Plain	PhD	2000-03	A/Prof J John	Curtin University
Halse, Stuart	Annette Mackintosh	Examining the ecology of stygofaunal ostracods in the Pilbara	PhD	2002-06	Dr P De Deckker	Australian National University

DCLM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Halse, Stuart	Jean-Michel Benier	Examining value of farm dams for the conservation of aquatic invertebrates in the wheatbelt as salinity increases	MSc	1997-03	A/Prof P Horwitz	Edith Cowan University
Harper, Richard	Peter Ritson	The growth and yield and carbon sequestration of *Pinus pinaster* established on farmland in south-western Australia	PhD	1997-03	Prof I Fergusson	University of Melbourne
Harper, Richard	Gabby Pracilio	Assessing the value of soil landscape (spatial) information from gamma radiometric, ground electromagnetic and topographic data for understanding the performance and potential returns from plant based applications in dryland agricultural regions	PhD		A/Prof K Smettem	University of Western Australia
Harper, Richard	Clare Robertson	Examination of geophysical techniques for site evaluation for farm-forestry	Hons	2003	Mr P Wilkes	Curtin University of Technology
Harper, Richard	Wesley Hibbett	Allelopathic effects of short rotations of eucalypts planted on farmland	Hons	2003	Prof J Fox	Curtin University of Technology
Macfarlane, Terry	Kelly Shepherd	Taxonomic and evolutionary study of the samphires (Chenopodiaceae subfamily Salicornioideae	PhD		Dr TColmer	University of Western Australia
Marlow, Nicky	Rachel Dawson	Examining the timing of reinvasion of baited areas by foxes and fox cat interactions in Dryandra	Honours	2003	Dr R Bencini	University of Western Australia
McGrath, John McCaw, Lachie	Robert Archibald	Role of fire and competition on the health and vitality of Tuart (*Eucalyptus gomphocephala*).	PhD	2003-06	Dr G Hardy and Dr B Bowen	Murdoch University
McGrath, John	Elfthoriu Dalmatis	Physiology of Wandoo decline (ARC project)	PhD	2003-06	Prof H Lambers and Dr E Veneklaas	University of Western Australia
McGrath, John	Ruth Kinal	Impact of stocking, nutrition and site on wood properties of blue gum (*E. globulus*)	Honours	2003	Dr E Veneklaas	University of Western Australia
Morris, Keith	Damien Cancilla	Ecology of the heath mouse *Pseudomys shortridgei*	PhD	2003-05	Dr M Garkaklis	Murdoch University
Morris, Keith	Helen Owen	Looking at the transmission of rickettsia disease by native animals	PhD	2003-05	Dr S Fenwick	Murdoch Vet School, Murdoch University
Morris, Keith	Felicity Donaldson	Social structure of burrowing bettongs	PhD	2003-05	Dr R Bencini	University of Western Australia
Morris, Keith	David Waayers	Sustainable turtle based tourism	PhD	2002-04	Dr D Newsome	Murdoch University
Pearson, Grant	Tanya Compton	The phenotypic response of the local Tellinidae to their environment	PhD	4 years	Prof T Piersma	Royal Netherlands Institute for Sea Research

DCLM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Pearson Grant	Danny Rogers	Conservation and Ecology of Migratory Shorebirds in Roebuck Bay	PhD	2002-04	Dr T Piersma	Charles Sturt University
Pearson, Grant	No student project	The role of stable isotopes in food webs in Roebuck Bay and Eighty-mile Beach			Dr A Storey Dr T Piersma	University of WA, Royal Netherlands Institute for Sea Research
Pearson, Grant	Suzanne Wade	The study of the intertidal mudflats at Eighty-mile Beach in 1999	Masters		Dr R Hickey	Royal Netherlands Institute for Sea Research, Central Washington University
Prince, Bob	Fiona Maxwell	David Waayers projects	Honours	2003	S Bradley	Murdoch University
Robinson, Richard	Peter Scott	Identification of the causal organism associated with stem canker disease in the rare and endangered meelup mallee (*Eucalyptus phylacis*)	Honours	2003	Dr G Hardy Dr T Burgess	Murdoch University
Shearer, Bryan	A. Koning	Processes in lateritic soil in Western Australia	PhD		Prof B Gilkes	University of Western Australia
Shearer, Bryan	R. Pilbeam	Phosphonate distribution in *Eucalyptus marginata* Donn ex Sm. forest and colonization by *Phytophthora cinnamomi* Rands	PhD		Dr G Hardy	Murdoch University
Shearer, Bryan	B. Komorek	Mode of action of phosphonate in native hosts to *Phytophthora cinnamomi*	PhD		Dr K Sivasithamparam	University of Western Australia
Shearer, Bryan	S. Collins	Survival of *Phytophthora cinnamomi* in rehabilitated bauxite mining areas	PhD		Dr G Hardy	Murdoch University
Shearer, Bryan	T. Papp	Epidemiology of Marri canker	PhD	2002-04	Dr G Hardy	Murdoch University
Shearer. Bryan	K. Smith	The role of chlamydospores in the survival of *Phytophthora cinnamomi*	PhD	2003-05	Dr G Hardy	Murdoch University
Start, Tony	Thalie Partridge	Study of fire, small mammals and cats in Purnululu National Park	PhD	2003-05		Macquarie University
Start, Tony	Carol Palmer	Study of 4 CWR mammals, their habitat requirements and the effect of fire on those requirements	PhD	2003-05	Dr J Woinarski	Northern Territory University
Stukely, M & Byrne, M	Margaret Wheeler	Reproductive biology and genetics of Jarrah	PhD		Prof J McComb	Murdoch University
Van Heurck, Paul	Delana Herath	The impact of wildfire on the beetle communities of the Walpole-Nornalup old growth forests	Honours	2002-03	Assoc Prof J Majer	Curtin University

DCLM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Yates, Colin	Andrew Franks	ARC Linkage Proj. Landscape fragmentation & rare plant species: can we develop a general framework of population responses?	PhD	2002-05		Murdoch University

Astronomical component

Biggs, James	Shane Walsh	Search for earth Trojan asteroids	3rd Yr research project	2002-03	Prof M Zadnik	Curtin University
Biggs, James	Margaret Peters	An upper limit to the number of Kuiper Belt objects (KBOs	3rd Yr research project	2002-03	Prof M Zadnik	Curtin University
Biggs, James	Anthony O'Brien	16" Telescope automation	3rd Yr research project	2002		Curtin University
Biggs, James	Owen Giersch	A study of the effects of binary motion on the detection of radio pulsars	Honours	2002		Curtin University

EXTERNAL PARTNERSHIPS

Biological component

Partnership Name	**Project -** i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	**Involvement ($)**	**Involvement (inkind)**
AGWA	GIS vegetation mapping	2002-03 - $20k 2003-04 - $10k	G Serendenco (0.3)
Bushfires CRC	Managing fires in forest landscapes SW Australia	$ 40k per annum over 7 yrs 2003-10 contributed by DCLM. $94k for next 4 yrs to fund PhD	L McCaw (0.4), R Robinson (0.2), J Farr (0.2), B Ward (0.2), G Liddelow (0.2), B Smith (0.2), J Neal (0.2), F Metcalfe (0.2), Li Shu (0.2), R Smith (0.1) (2.1 FTE per annum)
Assessment of the emission of dioxins from bushfire activity in Australia	Work is being conducted as part of Environment Australia's National Dioxins Program, co-ordinated through CSIRO Division of Atmospheric Research.	$ 10k funding made available from Environment Australia to cover costs of sampling emissions from bushfires in south-west WA	L McCaw, R Smith, J Neal; Total 0.3 FTE per annum. Other collaborators include National Research Centre for Environmental Toxicology and University of Melbourne.
Project Vesta – behaviour of summer fires in dry eucalypt forests	Collaborative fire research with CSIRO Forestry and Forest Products, with funding support from Australasian Fire Authorities Council.	$ 1 054k over 8 yrs 1995-03. Project completed July 2003. However ongoing finalisation of project until end 2003	L. McCaw, R. Smith, J Neal
Chevron-Texaco	Monitoring mammals on Barrow Island	$6k yr for 5 yrs	K Morris (0.05), A Burbidge (0.05)
CMAE / AGWA/ Gascoyne Murchison Project	Gascoyne Murchison Strategy	2002-03 - $180k 2003-04 - $150k	K Tinley (1.0), J Richardson (0.6), G Burke (0.5), J Richardson (1.0) for 25 days
CRC Tropical Savannas	Kimberley Mammals	$55k for 2002-03 $55k for 2002-04 DCLM contributes $10k yr into CRC Sally Black's contract was paid for by DCLM	T Start (0.8), N McKenzie (0.1), J Rolfe (0.1), S Black (0.25), A Burbidge (0.1)
CRC for Plant Based Management of Dryland Salinity	Program 2, sub-program 3 – how ecosystems are affected by salinity function. Program 4 sub- programs 4 and 6 Development of systems with balanced water use Program 7 – Potential Weeds and Monitoring wheatbelt wetlands Major national salinity research funding and coordination body. DCLM has 3 major projects pending that will deliver revenues of approx $400 k/yr	$100k per annum for 7 yrs, commenced 2001	J Bartle, B Maslin, D Cooper, R Harper, G Brennan, R Mazanec, M Byrne, J McGrath, B Copeland, R Hill, I Dumbrell, J Kinal, K Mungham, P Ryan, W Edgecombe, D Huxtable, A Stilwell, N Robinson, B Hingston, R Moore, M Lyons, S Halse, N Gibson. Total ± 8.2 FTE
ANZEC / CRC Weeds	Technical Group for weeds of conservation significance	Nil	G Keighery (0.05)
CRC Greenhouse Accounting	Project A2 Developing Carbon Accounting systems	In kind 1.9 FTR	P Ritson 0.5 (FPC), R Harper 0.3, J McGrath 0.2, I Dumbrell 0.3 (FPC), B Brand 0.5 (FPC), R McKellar (0.1), S Sochacki (1.0), CRC Funds – Totals 1.3 FTE from FPC, 0.6 FTE from DCLM
Dampier Salt	Pilbara survey	20 airfares Perth – Karratha - Return	S Van Leeuwen
Dept of Premier and Cabinet	Bushplan	$100k for 2003-04	A Hopkins (1.0)

Partnership Name	**Project -** i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	**Involvement ($)**	**Involvement (inkind)**
Dept of Primary Industries Victoria	PAPP toxicosis	To be advised	D Algar (0.02), K Morris (0.02)
Desert CRC	3 Scientists	No $ contribution	D Pearson (0.25), M Cowan (0.25), A Hopkins (0.5), K Tinley (1.0) + 1 more to be advised
Hamersley Iron	Pilbara Survey – rental of accommodation unit at Karratha	$690 month subsidized	S Van Leeuwen signed the contract
Joint Venture Agroforestry Program – ext partners at UWA	Phase Farming with Trees – Field validation and extension	In kind contribution only	R Harper (0.2) N Robinson (0.5)
LWA/CSIRO	Genetic & ecological viability of plant populations in remnant vegetation. (PhD scholarship)	$92k total ($67k LWA, $25k SAP) $7k DCLM contribution	D Coates (0.4), M Byrne (0.1), C Yates (0.2), C Elliott (1.0), B McDonald (0.1)
Millennium Seedbank Project	Seed collection, storage and biology	$105k yr to 2010	A Cochrane (0.8), D Coates (0.1)
Morgan	Feral cat research	$951k over 5 yrs	D Algar (1.0), N Hamilton (1.0), M Onus (1.0), J Angus (1.0)
Murdoch University	Western Barred, Gilbert's Potoroo, Quenda – ARC Linkage Grant	$15k pa for 3 yrs	T Friend (0.05)
Murdoch University/ Ravensthorpe Nickel	PhD student – D Cancilla Management guidelines for the threatened Heath Mouse and other rodent species in mining lease areas of southern WA	ARC Linkage Grant	B Johnson (0.4), K Morris (0.05), + $5 k yr for 2003-5 from Stipend funds (DCLM contribution)
Murdoch University	ARC Linkage Project – Landscape fragmentation and rare plant species. PhD student A Franks	$27 615 for 2002 $28 615 for 2003 $28 218 for 2004	C Yates (0.2), + $7500 yr for 2002-4 DCLM contribution
Murdoch University	Survival of *Phytophthora cinnamomi* in rehabilitated bauxite mining areas S Collins (PhD student)	Nil	B Shearer (0.04)
Murdoch University	Phosphonate distribution in *Eucalyptus marginata* Donn ex Sm. forest and colonization by *Phytophthora cinnamomi* Rands R Pilbeam (PhD student)	Nil	B Shearer (0.04)
Murdoch University	Epidemiology of Marri canker	Nil	B Shearer (0.4)
Murdoch University	Tuart woodland decline (ARC project) including support for a PhD student	$20k per yr	J McGrath (0.05), D Haswell (0.05), L McCaw (0.05)
Netherlands Institute for Sea Research (NIOZ)	Benthic studies – Roebuck Bay, NHT + Wettenhall – Roebuck Bay book	$27k	G Pearson (0.15)
Netherlands Institute for Sea Research (NIOZ)	PhD – T Compton	$5k from Stipend funds (DCLM)	G Pearson (0.05)
NHT	Protect island habitat from feral animals - Project 40977	$10k	A Burbidge - contract
NHT	Western Bristlebird Research Plan	$99 387	A H Burbidge (0.1), J Rolfe (0.05)
NHT	Dibbler Research	$13 727	T Friend (0.1)
NHT	Regional assessment of the conservation status of vegetation units throughout WA (Beard)	$31 525	A Hopkins (0.1)
NHT	Review and update of Ramsar	$6900	J Lane (0.15)

Partnership Name	**Project -** i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	**Involvement ($)**	**Involvement (inkind)**
PEST Animal CRC	Hons Project: fox re-invasion rates	Nil	N Marlow (0.05)
Robe River Mining (West Angelas Coondewanna West Environmental Off)	Fire-Mulga Study: post burn monitoring	$20k yr 2002-05 103 6000 2006-11	S Van Leeuwen (0.2), T Start (0.05), B Bromilow (0.2)
Robe River Mining (West Angelas Coondewanna West Environmental Off)	Wattles of the Pilbara	$68k for 2002 67, 830 for 2003	B Maslin (0.6)
Robe River Mining (West Angelas Coondewanna West environ Off)	A program to research and develop integrated control of Ruby Dock (*Acetosa vesicaria*) in the Pilbara	$47 250 yr for 2002 and 2003	S Van Leeuwen (0.2), C Mueller (0.2)
Robe River (West Angelas Coondewanna West Envion Off)	Botanical survey of Tussock Grassland communities in the Pilbara Biogeographical Region	$20 700 for 2002 $20 00 yr for 2003-05	S Van Leeuwen (0.2), B Bromilow (0.2)
UWA	PhD – F Donaldson Social structure of burrowing bettongs	$5k yr for 2003-05 from Stipend funds (DCLM)	K Morris (0.05) + equipment
UWA	Mode of action of phosphonate in native hosts to *Phytophthora cinnamomi* - PhD student – B Komorek	Nil	B Shearer (0.04)
UWA	Processes in lateritic soil in Western Australia - PhD student - A Koning	Nil	B Shearer (0.04)
University of WA	Physiology of Wandoo decline (ARC project) including support for a post doctorate position	$25k per yr	J McGrath (0.05)
Western Mining	Mulgarra work	$30k pa for 3 yrs finishes 2003	D Pearson (0.3)

Astronomical component

Partnership Name	**Project -** i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	**Involvement ($)**	**Involvement (inkind)**
Kent State University, USA; University of Cincinnati, USA, Edith Cowan University and Curtin University	ASTRONET - Perth Observatory Education and Information Core Functions	$2k	FTE Scientist, 0.1 FTE TO
Curtin University and UWA	Lecturing - Perth Observatory Education Core Function	-	0.2 FTE scientist
Curtin University and Murdoch University	Student project supervision (at tertiary level) - Perth Observatory Education Core Function	-	0.1 FTE scientist
Bureau of Meteorology	Weather monitoring - Perth Observatory Information Core Functions	-	0.01 FTE TO
Fire Protection Services, DCLM	Fire monitoring - Perth Observatory Information Core Functions	-	-
Lowell Observatory, USA and astronomers at the University of Maryland, USA, Perth Astronomical Research Group	SPP# 98/0010 Imaging And Spectrophotometry Of Comets	$2k	0.13 FTE scientist, 0.1 FTE TO
Astronomers - the Space Telescope Science Institute, USA; South African Astronomical Observatory; Institut d' Astrophysique, France; U Potsdam, Germany; University of St Andrews, Scotland & University of Tasmania	PLANET - SPP # 98/0013 Monitoring Gravitational Microlenses	$10k	0.45 FTE scientist, 0.12 FTE TO
IAU Minor Planet Centre, Harvard University	Asteroid tracking - SPP # 98/0012 Astrometry of minor planets, comets and targets of opportunity	$5k	0.23 FTE scientist, 0.52 FTE TO

Note: 1k = $1 000.

RESEARCH ACTIVITY

WESTERN AUSTRALIAN HERBARIUM

Group Manager: Dr Neville Marchant

COLLECTIONS MANAGEMENT

Core Function

Team members

C S Fang (0.8), N Marchant (0.2), K Knight (0.7), C Parker (0.5), P Spencer (0.5), S Carroll (0.4), K Veryard (1.0), M Falconer (1.0), B S Mahon (0.1), M Hislop (0.5), R Davis (1.0); Total (6.7).

Aim

To ensure the permanent preservation of the plant collections of Western Australian Herbarium and to care for and extend those collections so as to provide a framework for systematic research and biological information systems critical to the conservation of the state's flora and fauna.

Summary of progress

- 29,044 specimens were added to the collection, which now stands at 561 857.
- The major plant groups now in the collection are as follows:

Fungi	7 288
Algae	5 743
Mosses	5 370
Liverworts	1 437
Lichens	6 861
Ferns	3 025
Gymnosperms	1 723
Monocots	88 641
Dicots	441 760
Total	**561 857**

- Significant collections added to the Herbarium holdings were as follows:
  - SWALE (Surveying Western Australia's Land Edge) Project.
  - Woodland Watch (World Wildlife Fund).
  - Priority taxa for Swan Region by F Hort.
  - Lichens from FORESTCHECK by R Cranfield.
  - D Goodall, ex CSIRO collection.
  - Specimens from survey of Jaurdi Reserve, Coolgardie by L Sage.

- Volunteer participation again was significant, contributing 17 336 hours (equivalent to c. 10 FTE).
- Tasks carried out and/or assisted by volunteers were as follows:
  - Mounted 15 910 specimens.
  - Assisted in the curation of specimens.
  - Assisted in the incorporation of 29 000 specimens that were added to the collection this year.
  - Completed the DELTA scoring of the *Hakea, Chamelaucium* and weeds.
  - Validating plant chemistry vouchers.
  - Continued the validation of doubtful location outliers.
  - Validating the WE Blackall collection.

- Curated Droseraceae, *Austrostipa*, *Eucalyptus, Verticordia, Calandrinia* and native grasses.
- Identified specimens for the regional herbaria.
- Photographed type specimens.
- Captured and prepared composite images for FloraBase (see below).
- Increased the collection and documentation of Myxomycetes
- Maintained and increased the number of taxa represented in the Reference Herbarium.

- The Reference Herbarium now has 13 248 specimens representing c. 11 000 taxa.
- Over 1 500 visitors have used this resource to identify their plant specimens.
- The statewide Regional Herbarium Network continued to be supported with identification validation, vouchering and databasing.

Future directions
To continue extending the collection and to provide information on the flora of Western Australia.

BIOSYSTEMATICS OF THE WA FLORA

Team members
T Macfarlane (1.0), N Marchant (0.2), N Lander (0.5), B Rye (0.5), Vacancy ex J Wheeler (1.0), A Chapman (1.0), A Spooner (0.3), R Cranfield (0.9), M Trudgen (0.4), J Wege (1.0), B S Mahon (0.5); Total (7.3).

Aim
To provide an overview of botanical biodiversity in WA through reliable censuses and classifications of organism groups, definition of species, and provision of authoritative scientific nomenclature. Augmenting scientific collections of organisms and relevant database systems. Making the results available and useful through descriptive and image information and providing means of identifying organisms.

Summary of progress
1. Native plant taxonomy
Taxonomic studies of species on the Declared Rare and Priority Flora List
- Several species formally described, separately and as part of taxonomic revisions.

Taxonomic studies of Conservation Priority species
- Taxonomy of several groups clarified taxonomically, e.g. *Petrophile* (Proteaceae) and *Dicrastylis* (Lamiaceae) (B Rye).

Taxonomic studies in the family Poaceae
- Revision of *Amphipogon* completed and publication submitted (T Macfarlane).
- Book chapter prepared on classification of grasses (T Macfarlane).
- Interactive key to *Austrostipa* intended for FloraBase was further developed, and augmented with illustrations (T Macfarlane & A Williams).

Taxonomic studies in the Epacridaceae
- Progress concentrated on extensive *Leucopogon* specimen study and re-identification, improving the standard of identification in the collection, and hence the quality of FloraBase output (A Chapman & M Hislop).
- Paper describing a new species in *Conostephium* (R Cranfield).

Taxonomic studies in the Myrtaceae
- Paper published describing new species of *Micromyrtus* (Myrtaceae) (B Rye).
- Taxonomic revisions underway on *Astartea, Astus* (new genus), *Enekbatus* (new genus), *Cyathostemon* (reinstated genus), *Thryptomene* section *Astraea, Pterocarpus* (new genus), *Scholtzia,* and new species of *Micromyrtus* (B Rye and M Trudgen).
- Paper submitted on a taxonomic revision of the genus *Agonis* and two new genera *Taxandria* and *Paragonis* (J Wheeler and N Marchant).

- Research on Proteaceae: new species and a review of *Isopogon,* taxonomic update of *Petrophile* sect. *Arthrostigma,* new species of *Petrophile* (B Rye and M Hislop).

Taxonomic studies in the Dilleniaceae

- Two papers published on *Hibbertia*, revising several species groups and describing new species. Covers 10 species in total (J Wheeler).

Flora of the South West

- Book published and launched by the Minister for Environment and Heritage (J Wheeler, N Marchant & M Lewington)

Taxonomy of lichens

- Census of lichens for WA submitted for publication. This will serve as the basis for a lichen section of FloraBase (R Cranfield).

Taxonomy of Stylidiaceae

- Extensive field work was carried out, taxonomic study of various species groups with draft papers in preparation, a paper on chromosome numbers submitted, substantial re-identification of specimens achieved (J Wege).

2. Weed taxonomy, biosecurity assessment and incursion monitoring

- The system previously established was maintained, including links with Department of Agriculture and quarantine authorities (BS Mahon, M Hislop and others).

3. Managing the Herbarium's taxonomic journal *Nuytsia*

- One issue, Volume 15 (1), published, containing 17 papers and 156 pages.
- Editorship of *Nuytsia* has been transferred from B Rye to A Chapman.

FLORABASE

Core Function

FloraBase, the Web information system for WA flora, has increasingly become the main means of communicating botanical taxonomic information. It has been undergoing a major upgrade. Note that this project draws on the efforts of staff and volunteers from all Herbarium Programs.

Design and system aspects

- prioritization and implementation of FloraBase Review Action Items – completed.
- implementation of identical development and production environments for FloraBase – completed.
- implementation of concurrent versioning system (CVS) to manage file systems – completed.
- implementation of bug/feature tracking and reporting software (Mantis) to manage work flow – completed.
- implementation of a new database and web template infrastructure design – completed.
- implementation of a new registration system integrated into a more general task across multiple projects – progressing.
- implementation of a staged roll-out of features and improvements in subsequent versions – ongoing.
- addition of a 'browse mode' through the primary taxonomic hierarchy – completed.
- addition of maps and images for families and genera – completed.
- addition of further maps and images –ongoing.

Botanical content aspects

- addition of generic and family descriptions from the WAGenera project – completed.
- addition of an illustrated glossary – progressing.
- addition of other descriptive datasets for Weeds of WA and the genus *Hakea* – progressing.
- addition of interactive keys – commenced.
- addition of interactive mapping tools from NatureMap – commenced.

- addition of a phylogenetic tool for exploring higher-level systematics of WA Flora – commenced.
- maintenance of short descriptive data for all species (A Spooner and M Choo).

Technology transfer and promotion aspects
- presentation of FloraBase prototype to Divisional and Regional Managers and Corporate Executive – completed.
- publication of general articles and news items announcing the new version – ongoing.

Major new version
- publication of FloraBase2 online – completed.
- Official ministerial launch of FloraBase version 2 planned.

Future direction(s)
- Review of taxonomic situation with Declared Rare and Priority flora with the intention of formalizing the taxonomy of as many presumed new species as possible.
- Progress on a census of fungi for WA, as a basis for fungal information in FloraBase.
- Add new types of content to FloraBase, including interactive keys for identification of several plant groups.
- Progress with ongoing taxonomic studies of various plant groups to improve knowledge of the flora.

DCLM Region(s)
All.

IBRA Region(s)
All.

BIOLOGICAL INFORMATION SYSTEMS (BIS)

FloraBase
Core Function

A major upgrade of FloraBase, the Web information system for WA flora, has involved staff from all Herbarium Programs. For details see Biosystematics (above).

WACensus
Core Function

Team members
P Gioia (0.2), S Carroll (0.2); Total 0.4.

Aim
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.

Summary of progress
- Lichen census is now in press. Over 580 lichen names are currently being uploaded into WACensus.
- A total of 330 new names were added to WACensus, with 210 being new manuscript or phrase names and 133 names published.
- WACensus data are regularly distributed to over 150 registered Max users on a monthly basis

Future direction(s)
- Externally funding is being made available to employ a curator for fungi at the WA Herbarium.

- Work is continuing on migrating WACensus to a GUI environment.

WAHerb

Core Function

Team members
S Carroll (0.3); Total (0.3).

Aim
To manage 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.

Summary of progress
- A total of 30 589 records were added. Of these, 17 263 were entered as part of the AVH project. Other categories include WIN: 1 588; Regional Herbaria: 2 078 and Bioprospecting: 1 022. Additions by conservation status are: P1: 291; P2: 416; P3: 537; P4: 284; R: 291.Over 77 350 records were edited, representing nearly 10% of the entire database.
- The WAHerb database has been GDA-enabled. Records can now be output in a number of different coordinates systems and datums.
- Data can now exported using the HISPID standard. This enables other HISPID-compliant herbaria to import data without the need for re-keying.
- Online requests for data are now primarily handled through the FloraBase interface.

Future direction(s)
- The WAHerb data structure will be improved to accommodate site-based data entry from systematic surveys.
- Data fields will continue to be atomized into categories to accommodate normalized data entry.

Australia's Virtual Herbarium (AVH)

Core Function

Team members
A Chapman (0.2), E McGough (0.5), M Ware (0.5), S Arkeveldt (0.7), C Tause (0.5), M Hislop (0.2); Total (2.6).

Aim
To progress the databasing of the backlog of herbarium specimens at the Western Australian Herbarium.

Summary of progress
- Staff equivalent to 2 FTE have been employed in the necessary tasks of curating, identifying, databasing and validating the material to be incorporated into the main herbarium collection.
- 17 262 records have been processed. This added to the 16 543 in the previous financial year yields a total of 33 705 specimens processed as part of the AVH since project commencement in 2001.
- The project therefore remains on target to complete the databasing of the entire backlog of specimens by the end of this 5-yr national project.

Future direction(s)
- Validation of geocode statement and identification will be prioritized to ensure a consistent quality across the national collection, projected to total 6 million specimens.
- The distributed web mapping application for AVH will be given attention to ensure that the accumulating data is readily accessible through a reliable and intuitive interface.

DELIA (DELTA Database Engine)

SPP # 96/13

Team member
M Choo (0.7); Total (0.7).

Aim
To manage taxonomic projects and their associated data within an institutional framework.

This entails 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. DELIA may be viewed as an institutional complement to the existing DELTA system that effectively transforms project-oriented systems into a holistic institutional one.

Summary of progress
- The DELIA home page was developed and launched.
  URL = http://science.calm.wa.gov.au/projects/delia
- The first beta version of DELIA was released and made available over the Internet for comment and feedback.

Future direction(s)
- Feedback will be used to develop the first production version of DELIA.
- The DELIA approach to managing taxonomic data is currently being written up and targeted for international publication.

NatureMap

Core Function

Team member
P Gioia (0.4); Total (0.4).

Aim
To develop an online GIS tool for mapping a range of warehoused datasets in a single environment. 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.

Summary of progress
- Corporate level GIS hardware and software were purchased through Information Management Branch. NatureMap relies on this infrastructure to provide spatial data.
- A development version of NatureMap is now being previewed and tested by a selected number of DCLM staff. Initial results are positive. It has been demonstrated to a number of staff across the Department as well as senior management.

Future direction(s)
- A test version of NatureMap, utilizing the new GIS infrastructure, will be available for DCLM-wide testing within 6 months.
- The NatureMap engine will be integrated with FloraBase to give seamless mapping capabilities to FloraBase users.
- The development process for NatureMap V1 has been long. It is currently written using a mapping process now superseded by more recent software. NatureMap V2 will be written from the ground up to take advantage of the latest environment. Funding will be required to support this major upgrade.

Max

Core Function

Team member
P Gioia (0.1); Total (0.1).

Aim
To continue the development and maintenance of Max, 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.

Summary of progress
- A number of features have been added to Max including: full support for GDA co-ordinate and datum conversion; users can now define their own fields; improved ease of use for new or basic users; improved data importing from non-Max databases; improved reporting and querying.
- Over 300 users have registered to use Max with over 150 registered to receive regular monthly updates to names. Over 5 400 records were added to WaHerb using MAX over the last 12 month period, thereby avoiding re-keying.

Future direction(s)
New forms will be developed in Max to support site/species data. This will facilitate data entry from systematic survey more effectively.

Science Division LAN management

Core Function

Team members
P Gioia (0.2), N Lander (0.1), M Choo (0.1), B Richardson (0.2); Total (0.6).

Aim
To maintain and continually upgrade 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 Information Management Branch through a service level agreement.

Summary of progress
- Cabling at Science House and Kensington Research was upgraded to 100M bit capacity. All switches were also upgraded to handle 100M bit throughput. Additionally the link connecting Science House and Kensington Research to the main communications room was upgraded to 1Gb fibre link.
- The Science Division website was upgraded and implemented on a new server. Substantial improvements were made to the site, which is now visible on the Internet.
- The WASPP system was upgraded and its operation substantially simplified.

Future direction(s)
- As part of a rolling plan to continually upgrade each Science Division centre, the links connecting Woodvale and the Herbarium to Kensington will be assessed for bandwidth improvement where the technology and conditions are suitable.
- Manjimup cabling, currently linking a number of centers, will be increased to 1Gb capacity.

BIODIVERSITY CONSERVATION GROUP

Group Manager: Keith Morris

Animal ethics
Core Function

Team members
K Morris (0.05), N Marlow (0.05), J Smith; (0.4), other members P Mawson (Wildlife Branch), E Bennett (Consultant), J Butcher (Kanyana), G Archer (RSPCA), D Nickels (Veterinarian), N Cooper (WA Museum); DCLM Total (0.5).

Aim
To ensure that research and monitoring activities undertaken by DCLM staff on vertebrate fauna are conducted in a humane and ethical manner through compliance with the *Animal Welfare Act 2002.*

Summary of progress
- The AEC operates following the current guidelines provided by the 'Code of Practice for the Care and Use of Animal in Research in Australia (NHMRC/CSIRO)'.
- A list of Standard Operating Procedures relating to fauna research in the field has been developed.
- An approval application form was developed using the guidelines in the Code.
- Following the introduction of the *Animal Welfare Act 2002* and regulations, research institutions now need to have a 'licence to use animals for scientific purposes'.
- The new legislation requires annual reporting of current projects to the AEC committee and the appointment of general inspectors.
- 13 applications were approved in 2003/03.

Future direction(s)
- Ensure compliance with the *Animal Welfare Act 2002*.
- Provide a copy of the scientific licence to all staff involved in fauna research.
- Provide DCLM staff with information and guidance on the Animal Welfare Act and regulations.
- Update the application form to conduct fauna research – this will include new sections for staff competencies.
- Create a competency checklist for DCLM staff undertaking fauna research.
- AEC Chairman to provide an Annual Report to the Corporate Executive.
- Further develop the existing database on Animal Ethics issues.

BIOLOGICAL SURVEY AND RESERVE SYSTEM

Biological survey of the Pilbara Region (terrestrial component)
SPP # not yet approved

Team members
N McKenzie (0.5), AH Burbidge (0.2), G Keighery (0.01); S van Leeuwen (0.2), K Morris (0.05), J Rolfe (0.1), B Bromilow (0.1); Total (1.16).
Note: A number of other investigators from the Department's Pilbara Region, the WA Museum and elsewhere will also be involved.

Aim
- To provide a regional perspective on biodiversity and nature conservation priorities.
- To provide a regional context for the conservation implications of development proposals.

- To assess the adequacy of the existing reserve system and identify particular species or communities that warrant protection.
- To identify gradients in community composition, and the environmental factors related to these gradients, to provide a better understanding of plant and animal distributions and better data on which to base management actions.
- To provide systematic baseline data on the biota of the region and a framework for future monitoring of regional scale trends.

Summary of progress
- Funding packages and grant applications developed.
- Extensive liaison with stakeholders including mining companies, traditional owners and pastoralists.
- Site selection process initiated.
- Temporary staff appointed for pit establishment.
- Commenced logistical preparations for establishment of pit trap lines.

Future directions
Select first 150 sampling sites, establish pit lines and complete first sampling session by June 2004

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Floristic survey of the coastal communities of the Warren botanical subdistrict
SPP # 1993/0007

Team members
N Gibson (< 0.05); Total (< 0.05).

Aim
To allow a detailed assessment of the conservation status of plant species and plant communities in the Warren bioregion and will also develop an understanding of some the major threatening processes affecting these areas and develop management strategies to deal with these problems.

Summary of progress
No progress.

Future direction(s)
Further papers to write.

DCLM Region(s)
South West, Warren, South Coast.

IBRA Region(s)
Jarrah Forest, Warren.

Floristic survey of the Goldfields ranges
SPP # 1993/0166

Team members
N Gibson (0.05); Total (0.05).

Aim
To allow a detailed assessment of the conservation status of plant species and plant communities on a series of greenstone and banded ironstone ranges in the eastern goldfields region. It will also provide

baseline data against which proposed mining actives can be assessed.

Summary of progress
Two further papers in draft.

Future direction(s)
Synthesis paper to write.

DCLM Region(s)
Wheatbelt, Goldfields.

IBRA Region(s)
Avon Wheatbelt, Coolgardie.

Biological survey of Barlee Range Nature Reserve

SPP # 1993/0030

Team members
S van Leeuwen (0.2), B Bromilow (0.2), colleagues from Pilbara and Goldfield Regions; Total (0.4).

Aim

- To undertake a biological survey of the Barlee Range Nature Reserve to facilitate an assessment of its biological and nature conservation values. This will be achieved by comprehensively documenting the flora and fauna of the Nature Reserve using systematic and repetitive sampling regimes. The ensuing delineation of communities into which this biota is partitioned will be investigated using multivariate techniques.
- The aims of activities in 2002/03 were to undertake a LANDSCOPE Expedition to the Nature Reserve. The function of the 'Exploring Barlee' Expedition was to re-sample sites not sampled during the past 5 yrs and to visit remote locations in the reserve where biological inventory work had not been undertaken.

Summary of progress

- LANDSCOPE Expedition comprising 14 volunteers and 7 Departmental personnel was successfully completed in Aug 2002.
- Biological highlights of the expedition included exploring Wongida Creek, gathering valuable and informative subfossil material from Dusty Camp and the collection of numerous specimens of an undescribed *Bothriembryon* land snail. The collection of several plants that are new records for the Nature Reserve, including a fern (*Ampelopteris prolifera*) and small sedge (*Cyperus pulchellus*), both of which are typically found in tropical northern Australia, were also significant.
- Completed botanical identifications and provision of mounted and labelled vouchers to the PERTH herbaria and numerous eastern states herbaria.
- Completed LANDSCOPE Expedition report.
- Reviewed and finalized avifauna chapter for final report.
- Reassessed and corrected taxonomic changes to draft epigean ant chapter.
- Reassessed and refined flora chapter.
- Completed introductory chapters for final report.

Future direction(s)

- Complete flora chapter.
- Make recommendations to the Threatened Species Scientific Committee on the status of several plant taxa of conservation significance.
- Review mammal, reptile and land snail chapters.
- Compile final report.
- Publish final record as a supplement to the Records of the Western Australian Museum.

DCLM Region
Pilbara.

IBRA Region
Gascoyne.

Botanical survey of Hamersley Range uplands

SPP # 1993/0031

Team members
S van Leeuwen (0.25), B Bromilow (0.15); Total (0.4).

Aim
To comprehensively and quantitatively document the flora of upland habitats throughout the Hamersley Range, investigate the arrangement of these plants into floristic communities, identify the environmental correlates influencing the distribution of taxa and circumscription of communities and assess the biological and conservation status of such entities.

Summary of progress
- Final report submitted to Environment Australia.
- External funding acquitted and revenue account closed.
- Completed botanical identifications and provision of mounted and labelled vouchers to the PERTH herbarium and numerous eastern states herbaria.
- Provided advice to the Threatened Species Scientific Committee on the status of several taxa of conservation significance.
- Submitted taxonomic treatment to Nuytsia describing 2 new *Dampiera* species from the Hamersley Range.
- Prepared manuscript on the flora (checklist) of summit habitats throughout the Hamersley Range for publication in the Journal of the Royal Society of Western Australia.
- Prepared manuscript for Landscope magazine.
- Commenced analysis into patterns of nestedness, and α and β diversity observed in flora across the Hamersley Range.

Future direction(s)
- Prepare and submit manuscript to Australian Journal of Botany on floristic community patterns and influence of environmental variables on these patterns.
- Prepare and submit manuscript on patterns of floristic nestedness observed in flora from summit habitats across the Hamersley Range.
- Prepare Short Communication for Nuytsia on new botanical records for Western Australia.
- Provide advice to regulatory agencies on the conservation significance of selected mountain habitats.
- Provide advice and recommendations to land management agencies on the requirements for additional conservation reserves in the Hamersley Range to ensure adequate and comprehensive representation of the flora and floristic communities from mountain habitats.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Biological survey of Yanchep National Park

SPP # 1993/0033

Team members
A Burbidge (0.01), G Keighery (0.01); Total (0.02).

Aim
To determine patterns of community composition in the Yanchep National Park and the adjacent Ridges

area and to establish a series of permanent 'benchmark' quadrats for future monitoring of community change. A further aim was to gather data in a form that would allow objective comparisons with data from other surveys in the region, so as to enable the conservation value of the area to be placed in a regional context, thus providing a more objective assessment of its value to conservation.

Summary of progress
During the current reporting period:
- No significant progress in writing up.
- Addressed a public meeting at Wanneroo in connection with conservation values of local national parks.
- Provided advice to Planning Team staff in relation to the current revision of Yanchep/Neerabup NP Management Plan.

Future direction(s)
Produce written report for *Conservation Science Western Australia.*

DCLM Region
Swan.

IBRA Region
Swan Coastal Plain.

A biological survey of Cape Arid National Park
SPP # 1993/0034

Team members
A Burbidge (0.01), G Keighery (0.01); Total (0.02).

Aim
- To determine patterns of community composition in Cape Arid National Park and to establish a series of permanent 'benchmark' quadrats for possible future monitoring of community change.
- To gather data in a form that would allow objective comparisons with data from other surveys in the region, so as to enable the proposed reserve to be placed in a regional context, thus providing a more objective assessment of its value to conservation.

Summary of progress
During the current reporting period:
- No significant progress in writing up.
- Some advice provided to regional staff.

Future direction(s)
Produce written report for regional planning staff.

DCLM Region
South Coast.

IBRA Region
Esperance Plains.

Biological survey of the southern Carnarvon and northern Irwin Phytogeographic Districts
SPP # 1993/0035

Team members
A Burbidge (0.1), N McKenzie (0.1); Total (0.2).

Aim
To assess the adequacy of the current regional reserve system in the southern Carnarvon and northern Irwin Phytogeographic Districts on the basis of patterns of distribution of plants and animals, and to design an optimal regional reserve system which would fill major gaps identified by the above process.

Summary of progress
- Published a small companion volume containing the essence of the previously published 600 page scientific report, for the interested lay reader.
- This report has been provided to all pastoralists in the region, plus relevant libraries, local government offices, etc.
- A teacher's guide and resource kit has been produced and made available to schools.
- Advice provided to various managers and decision makers concerning conservation values in the Carnarvon Basin.

Future direction(s)
Project complete.

DCLM Region
Midwest.

IBRA Region
Carnarvon.

Floristic survey of remnant heaths and woodlands of the Swan Coastal Plain
SPP # 1993/0038

Team member
G Keighery (0.1); Total (0.1).

Aim
To prepare and publish results arising from surveys of the flora and vegetation of the Swan Coastal Plain.

Summary of progress
- Tuart Workshop Proceedings published.
- Six papers published on taxonomic outcomes of surveys, 2 in press.
- Tuart Conservation Status management group, re-mapped Tuart occurrences.
- Regional Parks Management Plan Group.
- Rottnest Island Scientific Advisory Group

Future direction(s)
- Complete taxonomic papers.
- Participate in project to deliver results to Perth Biodiversity Project and other NRM groups.

DCLM Region(s)
Swan, South West.

IBRA Region
Swan Coastal Plain.

Re-survey and analysis of F Podger's dieback sites after 30 years
SPP # 1996/0009

Team member
N Gibson (< 0.01); Total (< 0.01).

Aim
To examine change in vegetation communities 30 yrs after the deliberate introduction of dieback into forest and woodland communities in the Jarrah and Swan Coastal Plain Bioregions.

Summary of progress
No progress.

Future direction(s)
Several papers to write up.

DCLM Region
Swan.

IBRA Region(s)
Jarrah Forest, Swan Coastal Plain.

Taxonomy and zoogeography of aquatic oligochaetes of Western Australia

SPP # 1998/0008

Team member
A Pinder (0.05); Total (0.05).

Aim
To document the extent and distribution of aquatic oligochaete diversity in Western Australia. In particular, to identify specimens from various aquatic projects, describe new species and summarize knowledge of zoogeographical aspects in an Australian context.

Summary of progress
- Identified specimens from the Pilbara Stygofauna Survey, caves of the Leeuwin-Naturaliste region (for Stefan Eberhardt's PhD project), caves and springs from the Yanchep region and the SAP wheatbelt monitoring program.
- Recognized numerous undescribed species from the above projects, some of which will be published over the coming year.
- Published new records of naidid and tubificid oligochaetes from eastern Australia.
- Collected Western Australian specimens for international studies, including phylogenetic research based on molecular and sperm morphology data and developmental morphology work (all being carried out at the Swedish Museum of Natural History).
- Completed entry of systematic, distribution and ecological data for all freshwater and marine species into an internet-based database (the Australian Biological Information Facility) being collated by the Australian Biological Resources study.

Future direction(s)
- Identify specimens collected during the Pilbara stygofauna (SPP # 2002/004) and Pilbara surface water surveys.
- Publish descriptions of new species.
- Write a review of the occurrence of aquatic oligochaetes in subterranean habitats in Western Australia, based on preliminary data from the Pilbara groundwater project, the Yanchep caves, Leeuwin-Naturaliste caves, mound springs sampled for WATSCU and data from Brenton Knott at the University of Western Australia. This review to be presented at an international symposium on aquatic oligochaetes in the Netherlands and submitted to the journal Hydrobiologia.
- Improve curation and databasing of my collection.

DCLM Region(s)
Pilbara, Swan, South West, Wheatbelt.

IBRA Region(s)
Avon Wheatbelt, Jarrah Forest, Pilbara, Swan Coastal Plain, Warren.

Salinity Action Plan - Biological survey of the agricultural zone

SPP # 1998/0020

Team members
G Keighery (0.54), N Gibson (0.95), N McKenzie (0.5), AH Burbidge (0.5), M Lyons (0.2), S Halse (0.05), N Guthrie (0.25), W Muir (0.9), J Rolfe (0.83), P Van Heurck (0.5), N Hall (0.3); Total (5.52).

Aim
Regional biological survey of Western Australian agricultural zone.

Summary of progress
- Field work concluded, all trap lines dismantled.
- Data collated, databased, papers either written or being written.
- Four conference papers written for International Conference on Biodiversity and Salinity at Albany. Conference paper from Merredin Conference published.

Future direction(s)
- Publish report
- Future usage being considered (web based delivery).
- Engineering and Drainage Evaluation Group (Ministerial appointment).
- Projected 10 recovery catchments expanding to 25+, 6 underway.

DCLM Region(s)
Midwest, Wheatbelt, Swan, South Coast, Warren, South West.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain.

Biological survey of the Burrup Peninsula

SPP # 1999/0001

Team members
S van Leeuwen (0.05), B Bromilow (0.05), P Kendrick (Pilbara Region); Total (0.1)

Aim
To assess the biological and conservation significance of the Burrup Peninsula, by comprehensively documenting the flora and fauna (mammals, reptiles, land snails) present within the proposed conservation estate on the Peninsula, assessing the conservation status of known rare species (e.g. *Terminalia supranitifolia*), and augmenting the flora and fauna inventories for the Pilbara bioregion.

Summary of progress
- Completed all botanical identifications.
- Floristic dataset compiled.
- GIS atlas compiled.
- Recommended changes to the Priority Flora List and liaised with Threatened Species Scientific Committee.
- Provided interpretation and advice on the Burrup Peninsula flora and vegetation survey undertaken by Trudgen and Associates.
- Recommended management actions to industry for the control of the environmental weeds Ruby Dock and Caribbean Stylo.
- Reviewed environmental impact statements, made recommendations and provided advice on the potential environmental impacts of proposed industrial developments to Environmental Protection Branch, DEP, EPA and DOIR.

Future direction(s)
- Analyse floristic dataset and interpret results.
- Compile annotated bird list.
- Compile final report.
- Publish floristic research in peer reviewed scientific journal.
- Continue to provide scientific advice on the biological values of the Peninsula and make recommendations for management.
- Provide input into the Burrup Peninsula land use and management plan.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Botanical survey of central Hamersley Range tussock grasslands

SPP # 1999/0002

Team members
S Leeuwen (0.05), B Bromilow (0.05); Total (0.1).

Aim
To undertake a botanical survey of tussock grassland communities found on valley floors within the Central Hamersley Range. This survey will enable an assessment of the nature conservation values of such grasslands and their constituent species and facilitate the quantitative assessment of their representativeness and the adequacy of the existing conservation reserve network in the Pilbara region.

Summary of progress
- Completed all botanical identifications and proved mounted and labelled vouchers to the PERTH herbarium and numerous eastern states institutions.
- Provided advice to the Threatened Species Scientific Committee on the status of several plants of conservation significance.
- Commenced analysis into patterns of floristic richness and community composition.
- Reviewed environmental impact statements, made recommendations and provided advice on the potential environmental impacts of proposed industrial developments to Environmental Protection Branch, DEP, EPA and DOIR.
- Secured external funding from Robe River Mining to expand the project beyond the Central Hamersley Range to all tussock grasslands within the Pilbara bioregion.

Future direction(s)
- Prepare and submit manuscript to Australian Journal of Botany on floristic community patterns detected in Central Hamersley Range tussock grasslands and influence of environmental variables on these patterns.
- Prepare Short Communication for Nuytsia on new botanical records for Western Australia.
- Provide advice to regulatory agencies on the conservation significance of tussock grassland habitats in the Hamersley Range.
- Liaise with taxonomic colleagues and assist with the preparation of taxonomic treatments for several undescribed plants.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Biological survey of the south-western Little Sandy Desert

SPP # 1999/0003

Team members

S van Leeuwen (0.2), B Bromilow (0.2); Associated Science Division colleagues T Start, N McKenzie, R Cranfield (0.1); Colleagues from the Pilbara and Goldfields Regions; colleagues from the Botanic Gardens and Park Authority; DCLM Total (0.5).

Aim

- To document comprehensively, systematically and quantitatively the flora and fauna of the south-western Little Sandy Desert.
- To investigate the community arrangement of biota, identify how these communities were partitioned across the landscape and assess the biological and conservation significance of the species and communities encountered. The survey design involves a rigorous and comprehensive field program supported by herbarium, museum and laboratory analyses.

Summary of progress

- Prepared manuscripts and compiled final report to funding agency.
- Submitted final report to Environment Australia.
- External funding acquitted and revenue account closed.
- Completed botanical collecting trip to previously unsurveyed areas within the Jilyili Hills, Lake Sunshine and Beyondie Lake area.
- Provided advice to the Threatened Species Scientific Committee on the status of several plant taxa of conservation significance.
- Submitted a consignment of mounted and labelled voucher specimens to the Perth Herbarium and associated institutions in the eastern states.

Future direction(s)

- Prepare and submit manuscript to Records of the Western Australian Museum on the 'Biological Survey of the south-western Little Sandy Desert'.
- Compile and publish a floristic checklist for the Little Sandy Desert bioregion.
- Prepare and submit comparative manuscript describing differences in epigean ant faunas as determined by 2 sampling regimes.
- Prepare chapter manuscripts, in collaboration with Botanic Gardens and Park Authority colleagues, on the natural history of the Little Sandy Desert.
- Provide advice and recommendations to land management agencies on the requirements for a conservation reserve in the south-western Little Sandy Desert.

DCLM Region(s)

Pilbara, Goldfields.

IBRA Region(s)

Gascoyne, Little Sandy Desert.

Demography of Australian Boab (*Adansonia gregorii*) stands in relation to fire and grazing

SPP # 2000/04

Team members

N Burrows (0.01) T Start (0.01); Total (0.02).

Aim

To gather preliminary data on the impacts of current regimes of fire and grazing by cattle on the regeneration and size/age class structure of selected stands of boab trees in the Kimberley.

Summary of progress
Six sites near Kununurra, each with different but known recent histories of fire and grazing, have been surveyed. Belt transects were used to sample the size class structure, fire damage and reproductive status (flowers, fruits) of boabs at each site. Condition of the understorey vegetation was also described.

Future direction(s)
Data analysis will consist of comparing the structure of stands across sites and seeking patterns and relationships with fire and grazing history. Importantly, the analysis will seek to identify obstructions to recruitment that could be attributed to fire or to grazing or to both. A brief paper will be written in the next 12 months and submitted to the Journal of the Royal Society of WA.

DCLM Region
Kimberley.

IBRA Region
Victoria Bonaparte.

Fire regime effects on the structure and floristics of Jarrah forests

SPP # 1993/099

Team members
B Ward (0.2), G Liddelow (0.2), N Burrows (0.02); Total (0.42).

Aim
To investigate and monitor the long term impacts of 4 fire regimes on the floristic composition and structure of upland jarrah forest understorey vegetation.

Summary of progress
- Fire treatments have been maintained at each of the study sites (McCorkill, Lindsay and Yendicup forest blocks).
- Some aspects of the study (Lindsay) have been published in the proceedings of the Fire Symposium held in Perth April 2002.

Future direction(s)
- No field work is planned for another 2-3 yrs because of resource limitations. However, plots will be maintained and fire treatments will be imposed.
- Further data analysis and write up is planned for the coming 12 months.

DCLM Region
Warren.

IBRA Region(s)
Warren, Jarrah Forest.

Project Desert Dreaming: Developing sustainable management systems for the conservation of biodiversity at the landscape scale in the Gibson Desert and Gascoyne bioregions

SPP # 2003/004

Team members
N Burrows (0.05), D Algar (0.2), G Liddelow (0.2), B Ward (0.2), J Angas (0.2), N Hamilton (0.2), M Onus (0.2), Goldfields Regional staff, Prof T Bragg; Total (1.25).

Aim
- To develop efficient, effective and safe introduced predator (fox and feral cat) control technologies for the interior rangelands and the arid region.

- To reconstruct the original suite of native mammal fauna through re-introductions when sustainable feral cat control can be demonstrated.
- To implement a patch-burn strategy to create a fine-grained, fire-induced habitat mosaic to protect biodiversity and other values.
- To describe and predict pyric (post-fire) plant succession and describe the life histories of key plant species.
- To monitor the long term trends in species assemblages and abundance of small mammals and reptiles in an area where introduced predators are not controlled compared with an area where they are controlled.
- To model the relationship between seasons (rainfall) and the frequency and size of wildfires.

Summary of progress
- 2 papers have been submitted for publication (the review of Western Shield, the Journal of Arid Environments).
- Successful large-scale fox and feral cat baiting trials were carried out in the Gibson Desert Nature Reserve in winter 2002 resulting in an estimated 95% reduction in cat density. Ongoing monitoring has shown that feral cats have not yet recovered to their pre-baiting densities.
- Pitfall trapping of small mammals and reptiles has shown a positive response to feral predator control in the GDNR study area with capture rates in the baited area being almost double that in the unbaited area.
- Fire ecology (plants) sites were re-assessed. Data are being analysed.
- Over the last 2 yrs, large wildfires have burned the study area and the surrounding vegetation. The scale and intensity of the fires is a major concern.
- In partnership with Goldfields Regional staff and with the assistance and co-operation of Wiluna Aboriginal community members, a second (replicate) site has been established on the recently acquired Lorna Glen pastoral lease. Access tracks have been upgraded, fauna pit traps have been installed and opened, and the density of introduced predators has been assessed prior to trial baiting planned for this winter.

Future direction(s)
- Complete analysis and write-up of first stage of fire ecology (plants) study.
- Write-up and publish results of baiting trials in the GDNR in 2002.
- Continue to monitor re-invasion of feral cats at GDNR site.
- Carry out operational baiting trial on Lorna Glen.
- Continue monitoring small mammal and reptile response to introduced predator baiting at GDNR and Lorna Glen sites.
- Develop a fire management plan for the Lorna Glen study site.
- Continue assessment of vascular plants and invertebrates at the GDNR site.
- Consider developing a mammal reintroduction proposal for Lorna Glen site.

DCLM Region
Goldfields.

IBRA Region(s)
Gibson Desert, Gascoyne.

Monitoring selected vertebrate communities in the Perup Nature Reserve
SPP # 1997/009

Team members
G Liddelow (0.2), B Ward (0.2); Total (0.4).

Aim
- To monitor Woylie *(Bettongia penicilata)* and other selected vertebrate communities in the Perup Nature Reserve (PNR) in 2 different fuel ages, twice per year (spring and autumn).
- To monitor feral predators (fox and cat) using sand pads over time to assess the effectiveness of Western Shield baiting in the PNR.

- To train DCLM Bushrangers in mammal conservation and handling.

Summary of progress
- Populations of Woylies are stable, with normal distribution curves for ages.
- Captures for Woylies are high at c. 73%, with little variation between treatments and through time. It is unlikely to increase above this level because other traps are usually disturbed and not available for captures.
- Other vertebrates have to compete with the Woylies for the traps and even though their capture rates are low they are consistent with other areas of similar faunal suites.
- The numbers of feral predators are consistently low

Future direction(s)
Continue monitoring in the PNR at twice/year using the DCLM Bushrangers as a reward and teaching exercise in fauna handling and trapping techniques.

DCLM Region
Warren.

IBRA Region
Jarrah Forest.

Directory of important wetlands in Australia: revised editions
SPP # 1999/0014

Team members
J Lane (0.15), G Pearson (0.1), A Clarke (0.35), S Elscot (0.1); Total (0.7).

Aim
To prepare revised editions of the Western Australian Chapter of *A Directory of Important Wetlands in Australia* (Environment Australia 2001), incorporating additional wetlands and information. To periodically update the national database of Directory wetlands.

Summary of progress
- The most recent (3rd) edition of the Directory was published in 2001. Western Australia has 120 listed sites.
- Further research is needed to ensure that wetlands in remote regions of the State are adequately represented and well documented.
- Funding was provided from Environment Australia's Natural Heritage Trust National Funding Program in May 2003 for DCLM to undertake work leading to the nomination and improved documentation of nationally important wetlands in under-represented IBRA regions of the State.

Future direction(s)
- Representation of Western Australian wetlands in the Directory will be reviewed.
- Attention will be focused on IBRA regions with few listed sites and on the adequacy of documentation of these sites. Wetland literature relating to these regions and sites will be collated and analysed.
- This literature, specialist knowledge and existing biophysical maps, photographs and satellite images will be used to plan a program of wetland data and knowledge acquisition.
- Site managers and others with substantial relevant knowledge will be contacted and site visits and surveys conducted to collect field data and other information to support site listings.
- Specimens will be identified, data analysed and information synthesized.
- Descriptions of proposed new sites for the Directory will be prepared, together with enhanced descriptions of existing sites.
- The Western Australian component of the national Directory will be updated in 2005 to include these new sites and enhanced site descriptions.

DCLM Region(s)
Kimberley, Pilbara, Goldfields, Midwest.

IBRA Region(s)
Central Kimberley, Coolgardie, Murchison, Nullarbor, Ord Victoria Plains, Pilbara, Yalgoo.

Identification and monitoring of benthic invertebrate communities of tropical intertidal mudflats

SPP # 1999/15

Team members
J Lane (0.0), G Pearson (0.2); Total (0.2).

Aim
To facilitate and participate in research on the wildlife conservation values of intertidal mudflats including Roebuck Bay and Eighty-mile Beach.

Summary of progress
Roebuck Bay

- A major collaborative study of the whole of the intertidal mudflats of Roebuck Bay was completed in June 2002.
- The project attracted substantial external funding.
- Continued collaboration with other interest groups.
- A one-day information forum.
- Featured on Channel Nine 'Postcards WA', depicting the role of DCLM Science Division in wetland conservation.
- Landscope Expedition.

Eighty-Mile Beach

- Collected background information on Eighty-mile Beach through Dr R Hickey.
- Visited Eighty-mile Beach for discussion on Section 16a dual-purpose management reserve.
- Initiated analysis of data collected from the Eighty-mile Beach monitoring ('Monanna') Project.
- PhD Project - T Compton, Comparison of tropical and temperate bivalves in 2 intertidal mudflats.
- Promoter - Prof W Wolff.
- Supervisors: Dr T Piersma, G Pearson.
- University of Groningen, Netherlands Institute of Sea Research and the Department of Conservation and Land Management.
- The aim of this study will be to test the hypothesis that organisms have a wider distribution and physiological tolerance in a range of temperate relative to tropical regions.

Future direction(s)
Roebuck Bay

- A book on the ecology of the Bay. Funded by NHT, WWF and DCLM and published by DCLM. The book will extend public understanding of the conservation values of Roebuck Bay.
- A food-web study of the Bay incorporating use of stable isotopes, by RNIOZ, University of Western Australia and DCLM.
- Salary sought for an Education Officer/taxonomist based at Broome Bird Observatory working in collaboration with Environs Kimberley, employed by DCLM.
- Collaborate with Rubibi Aboriginal Group in a monitoring program of mangal and benthic communities at Dampier Creek.

Eighty-Mile Beach

- A program is being developed in collaboration with Karen Wheeler of MCB that might result in community monitoring of the crab fauna of parts of the Beach.
- Monitoring of the benthos continues through Broome Bird Observatory.

- Work is proceeding to establish a dual management reserve buffer along the seaboard from Cape Missiessy to Wallall Station.

DCLM Region
Kimberley.

IBRA Region
Dampierland.

Floristic survey of the Darling Scarp
SPP # 2002/0007

Team members
N Gibson (< 0.01); Total (< 0.01).

Aim
To assess the conservation status of plant species, plant communities in remnant bushland and regional parks along the Darling Scarp and will also develop an understanding of some the major threatening processes affecting these areas and develop management strategies to deal with these problems.

Summary of progress
No progress.

Future direction(s)
Several papers to write.

DCLM Region(s)
Swan, South West.

IBRA Region(s)
Jarrah Forest; Swan Coastal Plain.

Fauna of unflooded saline lake beds
SPP # 2002/0003

Team members
N McKenzie (0.01), N Guthrie (0.75), B Durant (1.0); Total (1.76).

Aim
To determine whether there is a fauna that is restricted to, or seasonally dependent on, unflooded saline floor environments (below the overflow point) at 5 wheatbelt wetlands.

Summary of progress
- SAP Arachnid data assembled.
- Field sampling of 5 lakes completed.
- Identification of all beetles and 5 spider families completed.
- Miscellaneous small spider families to be concluded.

Future direction(s)
- Complete report.
- Deposit voucher material in WA Museum.

DCLM Region(s)
Wheatbelt, Midwest.

IBRA Region(s)
Geraldton Sandplains, Avon-Wheatbelt.

A survey of the biodiversity of groundwater habitats of the Pilbara IBRA bioregion
SPP # 2002/0004

Team members
S Halse (0.8), M Scanlon (1.0); J Cocking (1.0); J McRae (1.0), A Pinder (0.95); Total (4.75).

Aim
To document and describe the stygofauna of the Pilbara and to begin ecological investigations of these species, especially in relation to physico-chemical parameters.

Summary of progress
- 230 samples collected from 160 boreholes.
- Animals from 100 samples have been sorted and identified. There was a greater array of animal groups than previously realized present in stygofaunal habitats of the Pilbara. Of particular interest were molluscs, polychaetes, platyhelminths and rotifers, as well as groups more typical of stygofauna such as amphipods, isopods, copepods, ostracods, thermosbaenids, bathynellids, mites, nematodes and oligochaetes.
- Several species previously known only from Barrow Island occurred in the Pilbara but new species were discovered as well, including possibly new families of calanoid copepod and amphipod.
- A workshop on stygofauna was organized at the Margaret River meeting of the Australian Society for Limnology in Sept 2002 to bring together potential collaborators.
- Formal collaborations have been established with the Western Australian Museum (T Karanovic, copepods) and Australian National University (P De Deckker and A Mackintosh, ostracods).
- J Bradbury of the South Australian Museum ran a specialist course of amphipod identification and has undertaken to provide further assistance.
- Interviews have been given on ABC radio and an article was prepared for The West Australian newspaper.

Future direction(s)
- Additional sampling will be undertaken in a greater range of bores.
- More animals will be sent to taxonomic experts for identification and description.
- Workshops will be held to acquaint consultants and other interested parties with the work we are doing and to facilitate the use of common codes for undescribed species.
- Additional methods of publicizing the work, including TV, will be examined.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

The status of critical weight range mammals in the Kimberley – a reassessment
SPP # 2003/0006

Team members
T Start (0.8), AA Burbidge (0.5), N McKenzie (0.1), J Rolfe (0.1), S Black (0.3); Total (1.8).

Aim
To determine whether there has been a change (decline) in status of CWR mammals of the north Kimberley in recent years. If so, to make recommendations on work needed so that the issue can be addressed by research and management.

Summary of progress
Field work commenced in May 2002. Preliminary analysis of these results commenced in June 2003.

Future direction(s)
- The results from this field work should establish a clear indication of whether the status of CWR mammals in the wet coastal northwest Kimberley has altered in recent decades.
- If CWR mammal populations appear to have remained more or less stable, we propose conducting surveys along a rainfall gradient from wet, coastal sites to more arid, inland sites and determine where declines become apparent (by locating sub-fossil material), analyzing old habitats/distribution data and comparing these to current distributions.
- If CWR mammal populations appear to have declined widely then we need to establish which taxa have been affected. We propose identifying sites where there are still extant populations of several species at which monitoring and research into causes of decline and management options to halt or reverse the effect of those causes can be conducted in future.

DCLM Region
Kimberley.

IBRA Region(s)
North Kimberley, Central Kimberley.

DISTURBANCE ECOLOGY AND MANAGEMENT

Biodiversity Audit
Core Function

Team members
N McKenzie (0.1), J May (1.0), B Johnson (0.3); Total (1.4).

Aim
To undertake an audit of Biodiversity at the IBRA scale for Western Australia.

Summary of progress
- Reports compiled for all regions.
- All reports refereed.
- Manuscript submitted for publication.

Future direction(s)
- Publish.
- Transfer results to operations.

Fire effects on desert vertebrates
SPP # 1993/0092

Team members
D Pearson (0.1), A Williams (0.1); Total (0.2).

Aim
To research the impacts of spring 'patchy' (= potential prescribed) fires and summer wildfires on the small terrestrial vertebrates, invertebrates and flora of hummock grassland in the Great Victoria Desert and make recommendations for management.

Summary of progress
- The Queen Victoria Spring study site is one of the few long-term fire monitoring sites in arid Australia (commenced 1986). A fire in Jan or Feb 2003 burnt the entire area, so the field component of the study

was discontinued in March 2003 with the removal of most traps.
- Invertebrate samples sorted by A Williams and reference collection of ants identified by Dr B Heterick of Curtin University. Spider samples are currently being identified by P Langlands, an Honours student at Curtin University.

Future direction(s)
- Recover remaining equipment from the Queen Victoria Spring site. Final vegetation sampling.
- Write up ant and spider data for publication in conjunction with B Heterick and P Langlands respectively.
- Analyse vertebrate trapping data and publish papers on fire impacts on dragon lizards, dasyurids and rodents.
- Lodge outstanding collections of flora with WA Herbarium and vertebrates with WA Museum.

DCLM Region
Goldfields.

IBRA Region(s)
Great Victoria Desert, Coolgardie.

Fire mulga study: post burn monitoring
SPP # 1993/0141

Team members
S van Leeuwen (0.05), B Bromilow (0.05), T Start (0.05); Total (0.15).

Aim
To investigate the effects of fire on the biota of Mulga communities in the Hamersley Range. The primary objective is to monitor the effects of controlled burns and wildfires on the biota of a number of previously identified Mulga woodland community types. Sampling strategies to achieve this outcome include the re-sampling of 24 permanent inventory sites and the resurvey of 70 km of transect.

Summary of progress
- Secured external funding from Robe River Mining to support the project for another 10 yrs.
- Provided advice to the Threatened Species Scientific Committee on the status of several plants of conservation significance.
- Continued plant identification process and refinement of floristic database.
- Commenced sorting of invertebrate samples.
- Provided advice to Pilbara Region on fire management of mulga woodlands and implications of wildfire suppression activities on biodiversity values of fire sensitive Mulga woodland communities.
- Reviewed environmental impact statements, made recommendations and provided advice on the potential environmental impacts of proposed developments to Environmental Protection Branch, DEP, EPA and DOIR.

Future direction(s)
- Complete botanical identifications and commence floristic analysis.
- Re-sample the 70 km of line transect and analyse change in community structure that has occurred as a consequence of fire.
- Prepare manuscript on the floristic differentiation between Mulga woodland communities within the Hamersley Range.
- Progress sorting on invertebrate samples and commence identification of ants.
- Refurbish permanent inventory sites and undertake a sampling session.
- Liaise with Ecosystem Research Group, School of Plant Biology, and the University of Western Australia over preparation of manuscripts for ‘Pilbara Disturbance Ecology’ book.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Monitoring of Carnac and Penguin Island Silver gull populations

SPP # 1999/0012

Team members
J Lane (0.05); other DCLM collaborator D Coughran;Total (0.05).

Aim
To monitor trends in the numbers of breeding pairs of Silver Gulls *Larus novaehollandiae* on Carnac and Penguin Islands, as an indicator of the effectiveness of DCLM's Perth metropolitan area gull management plan.

Summary of progress
Numbers of gulls on low-level, oblique, aerial photographs of Carnac and Penguin Islands taken in May of 2000, 2001 and 2002 were counted. Trends in gull numbers on these 2 islands since the project began 1994 were determined statistically. Preparations were made for the May 2003 survey. This will probably be the last survey for several years.

Future direction(s)
Following completion of the May 2003 aerial photographic census, trends in annual gull numbers on Carnac and Penguin Islands over the period 1994-2003 will be determined and a report prepared. This report will contribute to a Departmental review of Silver Gull management in the greater Perth Metropolitan Area.

DCLM Region
Swan.

IBRA Region
Swan Coastal Plain.

State Salinity Strategy wetland monitoring

SPP # 1998/0018

Team members
Fauna - S Halse (0.1), D Cale (0.5), M Pennifold, (0.2), R. Dodds (0.1); Flora - M Lyons (0.8), N Gibson (0.05); Surface water - J Lane (0.35), G Pearson (0.1), A Clarke (0.6), Y Winchcombe (0.3), B Johnson (0.05); Groundwater - S Halse (0.05), contracts; Total (3.2).

Aim
To monitor changes in biodiversity, surface water quantity and quality, and groundwater levels at selected Wheatbelt wetlands in relation to increasing dryland salinity and land-use changes.

Summary of progress
- Fauna monitoring – results from commencement of program in 1997 to April 2001 summarized in paper submitted to *Conservation Science Western Australia*. Monitoring for 2002-03 completed.
- Vegetation monitoring – monitoring for 2002-03 completed, collaboration began with CRC for Plant-based Management of Dryland Salinity on detailed measures of soil and plant vigour.
- Surface water monitoring – 2002 monitoring completed; database corrections and update completed; analyses of 1978-2000 depth and salinity data from 151 wetlands completed; compilation of 1978-2000 report well-advanced.
- Wetland bathymetry – mapping of lake bed, shoreline, inflow and outflow contours of Lakes Bryde, East Lake Bryde, Lake Warden System and part Yenyenning Lakes System completed. Maps and depth-volume calculators prepared.
- Groundwater monitoring – data loggers installed in all bores to be operational from mid-2003. Monitoring for 2002-03 completed.

- Management –contributed to Bryde, Buntine-Marchagee, Drummond, Muir, and Toolibin TAGs and provided advice to Warden Biodiversity Recovery Catchments, have advised on biodiversity aspects of drainage issues in Wheatbelt.
- Publicity – filmed Post Cards WA segment on faunal aspects of monitoring program to be screened in June 2003.

Future direction(s)
- Continue monitoring according to current protocols.
- Report on trends in depth and salinity of monitored wetlands from 1978-2000 to be completed.
- Compile bathymetric mapping of Lake Gore, Lake Mears and additional part of Yenyenning Lakes System.
- Monitoring bores to be surveyed to depth gauges.
- Analyse groundwater data.

DCLM Region(s)
Midwest, South Coast and Wheatbelt with 1 site in each of South West and Swan.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee.

Impacts of Dawesville channel on Peel-Harvey Estuary waterbirds

SPP # 1999/0016

Team members
J Lane (0.35), G Pearson (0.05), A Clarke (0.05), Y Winchcombe (0.05); Total (0.5).

Aim
To assess the impacts of the Dawesville Channel (completed in April 1994) on waterbird populations of Peel-Harvey Estuary.

Summary of progress
- The following reports were completed during 2002-03:
  Lane, J.A.K., Clarke, A.G. & Pearson, G.B. (2002). *Waterbirds of Peel-Harvey Estuary in 1996-97.* Department of Conservation and Land Management, Western Australia, pp. 1-41.
  Lane, J.A.K., Clarke, A.G. & Pearson, G.B. (2002). *Waterbirds of Peel-Harvey Estuary in 1998-99.* Department of Conservation and Land Management, Western Australia, pp. 1-40.
  Lane, J.A.K. & Pearson, G.B. (2002). *Waterbirds of Peel-Harvey Estuary in the Mid 1970s.* Department of Conservation and Land Management, Western Australia, pp. 1-73.
- Preparation of 3 related reports: *'Black Swan and Australian Pelican populations of Peel-Harvey Estuary'; 'Swans, pelicans and egrets on estuaries of south-western Australia in the 1970s' and 'Waterbirds of Leschenault Inlet in the early 1970s'* was commenced and is well-advanced.
- Planned field work for this project was completed in Feb 2001. Additional censuses of swans and pelicans were undertaken in Dec 2002, Feb 2003 and April 2003 due to Australia-wide drought conditions and an expected increase in waterbird numbers in coastal areas, possibly to pre-Dawesville Channel levels.

Future direction(s)
- The 3 partially-prepared reports referred to above will be completed.
- An additional 'comparisons' report, comparing the results of the pre- and post-Dawesville Channel waterbird surveys, will also be prepared.

DCLM Region
Swan.

IBRA Region
Swan Coastal Plain.

Management of the Vasse - Wonnerup wetlands

SPP # 1999/0017

Team members

J Lane (0.1), Y Winchcombe (0.05), G Pearson (0.05); Total (0.2).

Aim

To undertake monitoring programs that will enable impacts of water level and salinity management regimes of Vasse-Wonnerup to be assessed. The principal issues of interest in this project are impacts on waterbird populations, fringing plant communities and the occurrence of mass fish deaths.

Summary of progress

- A report on waterbird surveys undertaken between 1998 and 2001 has not been prepared, due to priority being given to other work. The fringing vegetation monitoring plots established in 2000 have not been revisited, due to priority being given to other work by the District.
- Monitoring of water levels in the Vasse and Wonnerup estuaries has been rationalized, by reducing the number of data loggers, relocating them to easy access points and having a locally-based officer download the data. Conversion (to Australian Height Datum) and graphing of data has been brought up-to-date during 2002-03.
- Monitoring of fish activity and water levels at the floodgates was undertaken during 2002-03. The Vasse estuary floodgates were opened on several occasions to maintain the target, summer-autumn, water level and to allow fish to pass. There were no mass fish death incidents in the Vasse or Wonnerup estuaries during summer-autumn of 2002-03.
- Meetings of the inter-agency Vasse Estuary Technical Working Group were convened to decide arrangements for summer opening of the sandbar at the wetland system mouth; for water level, water quality and fish monitoring, and for floodgate openings to release fish and manage water levels. The VETWG also provided technical advice to the Water Corporation regarding environmental aspects of the design and operation of the proposed replacement floodgates (scheduled for 2003-04).
- Advice was supplied in response to public queries about management of the wetland system and places to see waterbirds. Technical input was provided to the TWG responsible for preparation of the Draft Busselton Wetlands Conservation Strategy (BWCS; released April 2003).

Future direction(s)

- A concise report will be prepared, recording water levels, floodgate openings, fish releases and fish death incidents in the Vasse-Wonnerup system since the Dec 1997 report of Lane, Hardcastle, Tregonning & Holtfreter.
- Monitoring of water levels and fish activity during summer will continue. Gates will be opened as necessary to manage water levels and release fish. The VETWG will be convened as necessary.
- Further technical advice will be provided if needed concerning design and operational aspects (environmental) of the proposed replacement floodgates. Public enquiries concerning management of the wetlands will be responded to. Further technical input will be provided for finalization of the BWCS.

DCLM Region

South West.

IBRA Region

Swan Coastal Plain.

The impact of wildfire, in old growth forest of the Walpole-Nornalup National Park, on short-range endemic invertebrates and their forest floor communities

SPP # 2003/03

Team members

I Abbott (0.02), A Mellican (0.02), P Van Heurck (0.5); regional staff - E Middleton; Walpole-Nornalup Parks Association & Walpole community volunteers; Total (0.54).

Aim
To inventory the differences in species compositions of the arthropod litter communities containing short range endemics, at forest sites long unburnt, prescribed burnt and burnt in a recent wildfire.

Summary of progress
- 16 trapping sites established in Dec 2001.
- Sites trapped in Dec 2001, Feb 2002, Dec 2002 and April 2003.
- Volunteers trained in biosurvey methods in July 2002.
- 709 morphospecies sorted and added to Nuyts Collection by volunteers.
- Located several new populations of the short range endemic millipede (*Cynotelopus notabilis)*.
- The Nuyts Invertebrate Collection will contain a large proportion of invertebrate species previously undescribed from the old growth forests of the south coast. The distribution of these species within the wide range of fire ages surveyed will provide fire managers with important conservation information on a large segment of the local biodiversity, including short range endemic taxa.
- Due to the training of volunteers, from the Walpole Nornalup National Parks Association and the Walpole community, in biosurvey techniques, it has been possible to sort large numbers of specimens collected from the 4 trapping sessions. Volunteers have gained a greater understanding of the use of prescribed fire in the conservation of old growth forest biodiversity and are becoming increasingly interested and skilled in invertebrate biosurvey.

Future direction(s)
- Education of the local community through production of Discovery Centre displays, talks and photographic field guides.
- Supply of ecological information to local tour guides and operators.
- Education and attraction of tourists.
- Provision of a large species collection of an entire litter community for the use of local and international taxonomic specialists.
- Provision of a database, analysis and reporting of the species compositions of sites with different fire ages for the use of fire managers and planners in old growth forest parks.

DCLM Region
Warren.

IBRA Region
Warren.

FAUNA RECOVERY AND CONSERVATION

Assessing the distribution and status of the Wambenger
SPP # not yet approved

Team members
N Marlow (0.15), A Wayne (0.01), C Ward (0.01), A Williams (0.05); regional staff - I Wilson, E Shedley, G Durell, B Macmahon, K Williams, P Orell; Total (0.22).

Aim
- To determine if significant recent changes in distribution of Wambengers have occurred.
- To determine the reasons for any change in distribution of Wambengers.
- To determine the potential risk to Wambengers from operational fox baiting campaigns using ‘Probaits’.
- To determine the current conservation status of *Phascogale* nov. sp. using IUCN criteria.

Summary of progress
- Data on the historical and current distribution of Wambengers have been obtained from all Australian museums.

- Data on distribution and abundance have been obtained from all previous (known) studies of Wambengers.
- Study sites have been chosen for field trials to compare the relative densities of Wambengers in baited and unbaited sites in the Warren Region. (More sites may be added when additional populations of Wambengers are identified).

Future direction(s)
- Monitoring of nest boxes currently positioned within Wambenger habitat will be undertaken in June 2003.
- Nest boxes will be positioned in newly selected study sites as soon as possible.
- Monitoring of all nest boxes (in both extant and new study sites) will be undertaken annually in June and February.
- The uptake of biomarker-labelled Probaits by Wambengers will be determined.

DCLM Region(s)
Warren initially; may be expanded to include Swan and South West.

IBRA Region(s)
Jarrah Forest, Warren.

Conservation of Western Australian butterflies
SPP # 1993/0022

Team members
M Williams (0.4), A Williams (0.1); Total (0.5).

Aim
- To review the ecological and conservation knowledge available for WA's butterflies and determine critical gaps in that knowledge.
- To undertake strategic research to enhance our ecological knowledge of threatened taxa, and identify management strategies to enable effective conservation.
- To review the taxonomic status of those taxa where systematics is uncertain. Use genetic methods to better delimit those taxa.

Summary of progress
- Published scientific paper and Landscope article on the life history of the western flat.
- Completed and distributed progress report on first year of fieldwork, including initial data analysis of mark-recapture data and relationship between abundance and weather conditions.
- Completed 32 butterfly transect surveys at 5 metropolitan bushland sites comprising 9 fragments, and food- and nectar-plant surveys at each site. These included surveys of the critically endangered graceful sun moth.
- Completed second year of mark-recapture study of western jewels at Koondoola RBR.
- Completed abundance and habitat survey of a proposed critically endangered butterfly in Leeuwin-Naturaliste NP.
- Conducted initial survey of Kimberley region, expanding knowledge of butterfly distributions in WA.
- Databased entire DCLM collection of Lepidoptera.
- Constructed prototype flight interceptor trap to be trialled in 2003/4.
- Deposited samples for DNA analysis with Griffith and Harvard Universities.
- Prepared detailed comments on the draft Action Plan for Australian Butterflies.

Future direction(s)
- Complete and distribute report on second year of fieldwork.
- Conduct more surveys at existing sites and if possible incorporate additional sites into the study.
- Undertake third year of mark-recapture study of western jewels at Koondoola.
- Apply for funding for work on the arid bronze azure, a proposed critically endangered butterfly, and for the graceful sun moth.

DCLM Region
Swan.

IBRA Region
Swan Coastal Plain.

Conservation of marine turtles

SPP # 1993/0040

Team members
B Prince (0.75), K Morris (0.05), A Williams (0.05); Total (0.85).

Aim
To gain an understanding of the distribution and abundance of the various marine turtle populations utilizing Western Australian rookeries and marine habitats.

Summary of progress
- Review of turtle management in DCLM by Dr C Limpus undertaken.
- Marine turtle management plan resurrected.
- Indigenous take project on Dampier Peninsula completed, results presented at international conference in March 2003.
- Continued liaison with Commonwealth (EA, AFFA) regarding Browse Island turtle strategy – workshop in May 2003.

Future direction(s)
- Complete WA marine turtle management plan.
- Implement recommendations of turtle review, particularly with respect to establishing census beaches.
- Continue liaison with Districts and other stakeholders regarding turtle management.
- Develop an integrated turtle database – linking tagging, mortality and recruitment factors.
- Develop a research program for marine turtles in the MoU Box, including Browse Island.

DCLM Region(s)
Midwest, Pilbara, Kimberley.

IBRA Region(s)
Geraldton Sandplains, Carnarvon, Pilbara, Dampierland, North Kimberley.

Implementation of the recovery plan for the Chuditch *Dasyurus geoffroii*

SPP # 1993/0053

Team members
B Johnson (0.15), K Morris (0.05); Total (0.2).

Aim
To meet criteria for successful recovery as outlined in Chuditch Recovery Plan.

Summary of progress
- Awaiting confirmation that trap success criteria are being met and maintained at monitoring sites and that re-introductions to parts of their former range including semi-arid habitats have been successful.
- Publication of a review of the recovery program for Chuditch (Predators with Pouches book: CSIRO).
- Assessment of Chuditch take of cat baits.

Future direction(s)
- Analyse trapping data available from Western Shield sites.
- Resurvey semi-arid reintroduction sites.
- Undertake review of IUCN status.

DCLM Region(s)
Wheatbelt; South Coast; Swan; South West; Warren.

IBRA Region(s)
Jarrah Forest, Esperance Plains, Mallee, Avon Wheatbelt.

Conservation management of the Quokka, *Setonix brachyurus*

SPP # 1993/0054

Team members
P de Tores (0.8), M Hayward, full time PhD student (University of New South Wales) for the period 1998-2002; E Alacs, full time Honours student (Murdoch University) 1991; DCLM Total (0.8).

Aim
- To undertake a review of the distribution and conservation status of the Quokka, *Setonix brachyurus*.
- To quantify population size and habitat requirements of the Quokka at the sites within the Northern jarrah forest.
- To examine the genetics of populations at the demographic study sites in the Northern jarrah forest.
- To propose management strategies for conservation of the Quokka at mainland sites.

Summary of progress
Review of distribution and conservation status found:
- mainland populations suffered a widespread decline in the 1930s (well documented in historic accounts) and there has been a continued contraction in geographic range.
- there is a dearth of information on ecology of mainland populations.
- estimates of population size were available for 6 locations only, all within the Northern jarrah forest and estimates were derived from the current research program.
- despite having records of occurrence from 62 locations from the Northern jarrah forest and approximately 180 records of occurrence from the southern forest and south coast, with the exception of the above 6, there are no estimates of population size and almost all of these records are based on opportunistic sightings and infrequent (*ad hoc*) monitoring.
- The Quokka met the IUCN criteria for listing as a 'threatened species', in the category 'Vulnerable'.

The demographic and ecological study (M Hayward) found:
- Despite 6 yrs of fox control (1080 baiting) in the Northern jarrah forest, populations studied have shown no sign of increase and the remaining populations appear to be the terminal remnants of a collapsing metapopulation (results now published in Hayward, M. W., de Tores, P. J., Dillon, M. J. and Fox, B. J. (2003). Local population structure of a naturally occurring metapopulation of the Quokka (*Setonix brachyurus* Macropodidae: Marsupialia). *Biological Conservation,* 110, 343-355.).
- The presence of the Quokka in the Northern jarrah forest was found to be associated a specific habitat mosaic within swamps dominated and characterized by the presence of *Agonis linearifolia*. Results from analysis through use of General Linear Modelling (GLM) have specified this mosaic.

The genetics of Quokka s from the Northern jarrah forest (E Alacs) found:
- Genetic analysis of the Northern jarrah forest sites revealed low to moderate levels of genetic variability and further revealed the Rottnest island population is highly genetically differentiated from these mainland populations.
- Analysis also revealed low levels of gene flow between the Northern jarrah forest populations, indicating the populations are genetically distinct.

Proposed management strategies
Intervention management is recommended for the Northern jarrah forest populations. An active adaptive management approach has been recommended with specific actions including:

- Use of fire to manipulate swamps in the Northern jarrah forest and create the specific mosaic required by Quokkas;
- Monitoring response to habitat management; and
- Further examination of the genetics of Quokkas at Northern jarrah forest sites within the same and different catchments to test the metapopulation hypothesis (the findings from the demographic work advocating a former metapopulation need reconciling with the findings from the genetic work).

Future direction(s)
Recommended future directions, in addition to the management strategies above, include:
- Survey to determine presence at Muddy Lake, south of Bunbury;
- Estimate population size at a suite of sites within the same and different catchments within the southern forest and south coast regions;
- Examine the extent of movement within and between populations in these catchments;
- Survey to estimate population size of the Stirling Range sub-population(s);
- Assess the genetics of south coast, southern forest, Muddy Lake (if confirmed) and Stirling Range populations to determine the levels of genetic variability within each population and for the southern forest and south coast populations, determine the extent of genetic differentiation of populations within the same, nearby and geographically distant catchments;
- In conjunction with the demographic survey and genetic analyses of the southern forest and south coast populations, undertake spatial analyses of populations to ensure appropriate advice can be provided to managers to ensure long term conservation of the species over its geographic range; and
- Develop a model (using ANUCLIM) to predict Quokka occurrence throughout the species range, specifically in forest sites subject to disturbance from management operations (harvesting and burning) and ground truth this model.

DCLM Region(s)
- The demographic and genetic work was undertaken in Swan and South West regions.
- The findings from the research on the distribution and conservation status encompassed DCLM's Midwest, Swan, South West, Warren and South Coast regions.

IBRA Region(s)
- The demographic and genetic work was undertaken in Jarrah Forest IBRA region.
- The findings from the research on the distribution and conservation status encompassed the Swan Coastal Plain, Jarrah Forest, Warren and Esperance Plains IBRA regions, plus one record from each of the Avon Wheatbelt and Mallee IBRA regions (both of which were considered spurious by de Tores, PJ, Hayward, MW, Dillon, MJ and Brazell, R (in review). Review of the distribution and conservation status of the Quokka, *Setonix brachyurus* (Macropodidae: Marsupialia), an endemic macropod marsupial from south-west Western Australia. *submitted to Journal of Biogeography*,).

Conservation of the Western bristlebird
SPP # 1993/0065

Team members
A Burbidge (0.1), J Rolfe (0.05); Total (0.15).

Aim
- To develop an understanding of habitat requirements, including response to fire.
- To establish a viable translocated population in the Walpole area.
- To create management prescriptions that will increase the survival chances of the Ground parrot and increase its total population size.

Summary of progress
- In collaboration with regional staff, discussion paper developed concerning fire management at Waychinicup–Manypeaks.
- Monitored translocated population in Walpole–Nornalup NP and assessed options for further

translocations.
- All contemporary and historical records brought into a digital environment, for use in a GIS, to facilitate planning of specific management actions.

Future direction(s)
- Validate accuracy of all location records using GIS framework.
- Monitor translocated population in Walpole–Nornalup NP.
- Assess response to fire in Fitzgerald River NP.
- Write report/ publication on the effects of fire on bristlebirds.
- Write recovery plan.

DCLM Region(s)
South Coast, Warren.

IBRA Region(s)
Esperance Plains, Jarrah Forest, Warren.

Conservation management of the Western ringtail possum, *Pseudocheirus occidentalis*

SPP # 1993/0142

Team members
P de Tores (0.15); Total (0.15).

Aim
- To undertake a review of the distribution and conservation status of the Western ringtail possum, *Pseudocheirus occidentalis*.
- To determine translocation success at Leschenault Peninsula Conservation Park and Yalgorup National Park.

Summary of progress
Review of distribution and conservation status found:
- The geographic range (extent of occurrence) increased from that inferred by Jones *et al*. (1994);
- This range was extended by confirmation of records of occurrence in jarrah/marri forest near Collie, Bunbury and Australind, with riverine stands of peppermint near the Harvey River, east of Harvey. The range extension was attributed to a greater awareness of the Western ringtail possum and an increase in the number of known records of occurrence. It was not seen as an indication of recovery or partial recovery of the species;
- Threats to the Collie and Harvey River populations were identified as fox predation and habitat modification;
- Threats to the Bunbury and Busselton populations were identified as habitat fragmentation associated with urban development;
- Threats from urban development also apply to a lesser extent to the south coast populations near Albany;
- Threats to the Manjimup populations were identified as predation and increased predation risk associated with timber harvesting operations; see Wayne *et al*. (2000) and Wayne *et al*. (2001b).
- the western ringtail possum met IUCN criteria for 'threatened species', category of 'Vulnerable'.

The Leschenault Peninsula CP and Yalgorup NP translocations:
- The 2002 spotlight survey at Leschenault CP revealed a significant decline in the number of sightings of Western ringtail possums, however sightings of the Common brushtail possum remained constant. It was previously proposed this decline in Western ringtail possums was a result of missed 1080 baiting events and changes to the baiting regime at Leschenault. Alternative hypotheses for the decline were also listed and included competition with the Common brushtail possum. The spotlight data from Leschenault and Yalgorup and now been re analysed (Distance sampling protocols) and suggest habitat partitioning between the ringtail and brushtail populations and further suggests that competition was not

the cause of the decline.

Future direction(s)

- Assess community expectations of a state government agency entrusted with the responsibility for management of conservation estate, specifically, assess community attitudes to use of 1080 baiting for fox control and the conflict (real or perceived) between management for conservation and visitor use.
- Resolve the conflict (for managers) between conservation and visitor use objectives - specifically, long term security of baiting programs needs to be established and if changes are made to existing regimes, it should be in the knowledge of the potential compromise to the conservation values, and after a comprehensive risk assessment, and in light of public expectations of a conservation management agency.
- Ensure that endorsed baiting regimes are implemented.
- Determine long term success of Leschenault, Yalgorup and Lane Poole translocations before commencing additional relocations at new sites and in doing so, assess the importance of:
  - Competition with *in situ* populations of brushtail possums;
  - Predation by other predators (cats, pythons, chuditch);
  - Suitability of habitat; and
  - Prey switching.

DCLM Region(s)
Midwest, Wheatbelt, Swan, South West, Warren, South Coast.

IBRA Region(s)
Geraldton Sandplains, Avon Wheatbelt, Swan Coastal Plain, Jarrah Forest, Warren, Esperance Plains, Mallee.

Factors affecting establishment in the Numbat recovery program

SPP # 1993/0145

Team members
T Friend (0.15), N Thomas (0.5); Total (0.65).

Aim

- To measure the success of establishment of Numbat populations through re-introduction.
- To attribute mortality to specific causes.
- If population growth is zero or negative, remove one of the factors causing mortality. Assess the effect of removing the cause of mortality on the growth of the population.

Summary of progress

- Monitoring of Numbat populations is carried out by 3 methods: 1) following the progress of radio-collared animals after release, 2) driven surveys in areas where visibility and/or Numbat densities are high is high and 3) searches for diggings. The following results have been obtained this year:
- Captive-bred Numbats were released at Stirling Range NP for the fifth year and monitored by radio-tracking. This is the third year of an experiment to determine the effect of predator training. Due to collar failure, only 8 of 15 animals were recovered. This year's data will be combined with previous years results to assess the effectiveness of the training in reducing mortality soon after release.
- Mortality is principally due to predation by raptors.
- Driven surveys have been carried out at Dryandra and Boyagin NR. Numbers are slightly up on last year.
- Diggings surveys have been carried out at Boyagin, Batalling and Dryandra. Numbat populations have persisted and some population growth has been recorded.

Future direction(s)

- Monitoring will be continued as funds permit, with an increased effort to involve District staff and hand over monitoring. Surveys will be essential in Dragon Rocks, Karroun Hill, Northern jarrah forest east of Mundaring, Dryandra and Boyagin. Other areas will be included if possible.

- Another release will occur next year, with recovery team input into the location.
- Surveys for Numbats and cats at Dragon Rocks and Karroun Hill NR will be carried out in 2003/04.
- A review of Numbat translocations will be completed by the end of Aug 2003. The recovery plan will be revised and submitted for adoption by the Commonwealth in 2003/04.

DCLM Region(s)
Swan, Wheatbelt, South Coast.

IBRA Region(s)
Swan Coastal Plain, Warren, Jarrah Forest, Avon Wheatbelt, Mallee, Yalgoo.

An assessment of the effect of fox control on Red-tailed phascogale populations

SPP # 1993/0149

Team members
T Friend (< 0.1), N Thomas (< 0.1); Total (< 0.1).

Aim
To assess the effect of fox control on populations of the Red-tailed phascogale *Phascogale calura.*

Summary of progress
- This project commenced in 1993 and 9 populations, in long-term baited, newly baited and unbaited reserves were monitored intensively by trapping for the next 4 yrs. Lack of funding prevented further intensive work, but some trapping was carried out in 1997 and 2000. Narrogin District requested that baiting cease on 2 of these reserves in 2003 so a final trapping session was conducted in April/May 2003.
- Trapping was conducted by Science Division, and Narrogin and Katanning District staff. Data have not been fully analysed but the results indicate that fox control does not have a clearly beneficial effect on populations on these reserves. Since the sites are widely spread over the upper Great Southern, site and rainfall data will have to be incorporated in the analysis.

Future direction(s)
- Results of this project will be written up during 2003/04. However it would be valuable to establish an ongoing (e.g. 2-yrly) monitoring round and this is likely to receive some District support.
- A recovery plan for the RTP will be written with EA funding in 2003/04 and will involve community input. An action will be to marshall community resources to further this study.

DCLM Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

Operation Foxglove, large scale fox control in the Northern jarrah forest of south-west Western Australia

SPP # 1993/0157

Team members
P de Tores (0.05); Total (0.05).

Aim
To progress data entry, analyses and write-up.

Summary of progress
- Data entry (exclusive of GIS component, see below) was completed.
- Absence of the funds requested last year for GIS support has prevented final GIS work and final

survivorship and co-variate analysis.

Future direction(s)
Recommended future directions are subject to final analyses, however, recommendations to date are as previously noted and include:

- The standard 4 baitings per year prescription for aerial baiting needs to be revised to incorporate a higher frequency (6 baitings per year) at the interface of forest and agricultural land;
- Foxglove data suggest fauna abundance and distribution in the Northern jarrah forest is highly unlikely to be a function of a single dimensional causal factor such as predation. Management of the Northern jarrah forest (including harvesting and burning) should incorporate quantified data on the importance of habitat factors;
- The previously identified sites where Foxglove grids have been established in long unburnt forest and uncut forest should be retained as long term monitoring sites;
- The fate of the translocated Woylies should be determined.

DCLM Region(s)
Swan, South West.

IBRA Region
Jarrah Forest.

Ecology and conservation of Carpet and Woma pythons

SPP # 1993/0159

Team members
D Pearson (0.15), A Williams (0.1); regional staff at Denham - K Himbeck, M True; Total (0.25).

Aim
To document the ecology (habitat preferences, refugia, diet, reproduction, home range use and activity patterns), distribution, status and threats to the conservation of 2 species of threatened python and determine possible management actions.

Summary of progress

- Carpet python telemetry completed in March 2001 and 4 papers on this work published in international journals.
- Completion of PhD thesis in March 2002 covering the carpet python work.
- Ongoing sighting survey with DCLM staff and the public; 1 publication on this aspect.
- Continued mark recapture studies on 2 populations; West Wallabi Island (100 individuals) and Garden Island (760 individuals) and survey of poorly known populations (East Wallabi and Mondrain Islands) to collect long term population trend data, recruitment rates and growth data.
- Ongoing research on captive breeding of Woma pythons.
- Implantation of transmitters in 6 Woma pythons on Peron Peninsula and their monitoring by local DCLM staff.
- Collection of material for taxonomic work on south-western population of Woma pythons.

Future direction(s)

- Publication of further 3 papers and a Landscope article from Carpet python research. Seminar on Carpet python research at DCLM Narrogin.
- Woma python telemetry (2-3 yrs) and subsequent write-ups.
- In conjunction with DCLM Midwest staff, undertake further searches to locate an extant population of Woma pythons in the northern Wheatbelt.
- Continuation of mark-recapture studies on Garden, West Wallabi and Mondrain Islands.
- Paper on taxonomic status of south-western Woma pythons based on meristics and morphometric data collected from Museum specimens and wild caught individuals.

DCLM Region(s)
Swan, Wheatbelt, Midwest.

IBRA Region(s)
Avon Wheatbelt, Swan Coastal Plain, Murchison.

Genetics and ecology of the Western barred bandicoot

SPP # 1993/0163

Team members
T Friend (< 0.05), N Thomas (< 0.05); Total (< 0.1).

Aim
- To achieve an understanding of the habitat requirements, habitat usage, breeding biology and spatial organization of the Western barred bandicoot.
- To assess genetic difference between populations of Western barred bandicoots on Bernier and Dorre islands, Shark Bay using PCR and DNA sequencing.
- To assess the viability and fertility of progeny from matings between Dorre Island and Bernier Island individuals.

Summary of progress
- Workshop convened to discuss disease issues in the WBB and to map out future action. This aspect is now being covered under the Return to Dryandra project run by N Marlow and N Thomas.
- One of the actions from the workshop was to monitor disease on the Dorre and Bernier Island populations and this trip in Feb 2003 included population monitoring by trapping at the White Beach grids used in this project.

Future direction(s)
- Ear tissue material collected under this project will be submitted for analysis to determine genetic differences between the island populations.
- The results of the cross-breeding experiment conducted at Kanyana Wildlife Rehabilitation Centre commencing in 1994 will be written up in 2003/04.

DCLM Region
Midwest.

IBRA Region(s)
Geraldton Sandplains, Carnarvon.

Dibbler Recovery Plan

SPP # 1995/0011

Team members
T Friend (0.1), consultant (0.25); Total (0.35).

Aim
To implement the Dibbler Recovery Plan, and improve the conservation status of the Dibbler by increasing the number of known populations by searching for unknown populations and re-establishing Dibblers in areas where they have become extinct.

Summary of progress
- The second release of captive-bred dibblers (46 individuals) at Peniup, the first mainland re-introduction site, was carried out in Oct 2002. Monitoring by trapping has continued, assisted by local community members. Dibblers have persisted at the site since the Oct 2001 release, females have been found with attached young, and independent site-bred progeny have been captured.
- Annabelle Stewart has commenced a PhD study of mammal interactions on the Jurien Bay islands

(Boullanger, Whitlock and Escape). One aspect being examined is the possibility of dibbler predation on mice.
- Dibbler surveys have continued at Torndirrup and Waychinicup. Hair tubing is now being used to reduce cost and increase coverage of surveys.

Future direction(s)
- Monitoring of the Peniup translocation and the FRNP populations will continue.
- Subject to recovery team support, a third release will be carried out at Peniup. Limited radio-tracking will be carried out to provide home range estimates provide a comparison with FRNP data.
- Dibbler surveys will be extended eastwards. Meanwhile the Denmark Environment Centre's Gilbert's Potoroo survey west of Albany using hair-arching also has the potential to discover dibbler populations.

DCLM Region(s)
Midwest, South Coast.

IBRA Region(s)
Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Esperance Plains.

Experimental management and monitoring of Western desert rock-wallaby populations

SPP # 1995/0016

Team members
D Pearson (0.15); Regional staff Goldfields, Ngaanyatjarra and Western Desert Land Councils; Total (0.15).

Aim
To undertake research and management actions in association with DCLM staff and Aboriginal organizations to conserve rock-wallabies and associated rare mammal populations in desert regions.

Summary of progress
- Ongoing baiting program conducted by Ngaanyatjarra Council at the Townsend Ridges to protect a unique genetic race of Rock-wallabies. Area burnt by wildfire in summer 2002, so monitoring has focused on the ability of the colony to survive this event.
- Handing over the day-to-day management of the DCLM-Ngaanyatjarra relationship in relation to Townsend Ridges to Goldfields Region.
- Establishment of Bilby survey and monitoring program at Tjirrkarli, the southern-most wild population of the species (TSN grant to Ngaanyatjarra Council).
- Monitoring other Rock-wallaby populations: Calvert Range (with DCLM Pilbara), Mondrain Island post-fire (with DCLM South Coast), Barrow Island (with Science Div. staff).
- Survey for Mulgara and Ampurtas along the Canning Stock Route with Western Desert Aboriginal communities and NT Arid Lands Environment Centre (TSN grant) in July 2002.

Future direction(s)
- Establishment of Rock-wallaby recovery team covering all taxa in WA to provide a forum for improvement in management operations and to encourage focused relevant research by DCLM and tertiary institutions.
- Continued scientific support (Rock-wallaby trapping/monitoring and genetic sampling) for management of populations in the Calvert Range, Townsend Ridges, Barrow Island, Recherche Archipelago and desert locations.
- Publication of West Kimberley survey (with M Eldridge, Macquarie University).

DCLM Region
Goldfields.

IBRA Region
Murchison.

Fox population dynamics

SPP # 1996/ 0001

Team member
N Marlow (0.01); Total (0.01).

Aim
To investigate the impact of reducing density on the reproductive success of foxes.

Summary of progress
- Field work complete.
- Data analysis complete.
- Final draft of manuscript undergoing internal review.

Future direction(s)
Submission of manuscript to journal.

DCLM Region
Midwest.

IBRA Region(s)
Carnarvon, Gascoyne, Murchison.

Gilbert's potoroo Recovery Plan

SPP # 1996/0008

Team members
T Friend (0.75), S Hill (1.0), S Hands (0.5); Total (2.25).

Aim
To implement the Gilbert's Potoroo Recovery Plan, and particularly to increase the numbers of individual Gilbert's Potoroos known to be alive in the wild and to increase the number of locations in which they occur.

Summary of progress
- Demographic study of GP population at Two Peoples Bay indicated a surplus of young, given the limited nature of the habitat.
- New colony of 4 animals discovered on Mt Gardner.
- Radio-tracking studies showed:
  - Young animals survive well and disperse to other parts of Mt Gardner.
  - Little overlap occurs between animals of the same sex.
  - Core habitat has been described.
- Refined captive management techniques.
- Ongoing study of *Treponema* infection in captive and wild populations.
- Supported Perth Zoo attempt to develop artificial insemination techniques.
- Commenced cross-fostering trial with Adelaide University – one pouch young transferred to long-nosed potoroo in Adelaide, 3 more to go.
- Truffle analyses completed.
- Supported Murdoch University Honours student J Whelan's study of the effect of *Phytophthora* on diet of mycophagous mammals (bush rats) in Waychinicup NP. This study should throw light on the effect of dieback on truffle-like fungi, with direct implications for GP.
- Supported Denmark Environment Centre hair-tubing project west of Albany.
- Hair-arching carried out in 3 sites east of Albany.
- Supported development of cat trapping regime at Two Peoples Bay using small enclosures and leg-hold traps.

Future direction(s)
- Design new captive diet based on truffle analysis.
- Continue radio-tracking juveniles to determine fate.
- Complete cross-fostering trial.
- If cross-fostering is viable, establish a long-nosed potoroo colony in Albany.
- Assess 2 potential translocation sites.
- Carry out a trial release of 2-3 pioneer animals at a proposed translocation site.
- Monitor condition and establishment of pioneer animals.
- Support Perth Zoo efforts to develop AI techniques in long-nosed potoroos.

DCLM Region
South Coast.

IBRA Region
Jarrah Forest.

Status, ecology and conservation of Pilbara Olive pythons
SPP # 1998/005

Team member
D Pearson (0.2), Regional staff, Millstream and Nickol Bay Naturalist Club volunteers; Total (0.2).

Aim
To determine the distribution, status, habitat requirements, prey preferences, activity patterns and reproductive behaviour of the threatened Pilbara Olive python and make recommendations on its conservation status and management.

Summary of progress
- Collection of telemetry data by volunteers at 4 sites in the Pilbara (Pannawonica, Tom Price, Millstream and Burrup Peninsula. Telemetry work at Pannawonica and Tom Price now complete, ongoing at other sites.
- Preparation of report to Environment Australia on Threatened Species Network grant with Nickol Bay Naturalist Club to study Burrup Peninsula population.
- Two consultancy reports (BGC and Burrup Fertilizer) regarding the presence of Olive pythons on plant sites and their removal.
- Preparation with Nickol Bay Naturalist Club of information poster on Olive pythons.
- Provision of information to Environment Australia concerning the species status in the Pilbara.
- Collection of meristic, morphometric and genetic material.
- Consultant for 2 film crews (VOX Teirzeit and Prospero Productions) shooting documentaries about Pilbara Olive pythons.
- Efforts to captive breed the species.

Future direction(s)
- Analysis and publication of Pannawonica telemetry data.
- Ongoing support for telemetry operations at Millstream and Burrup Peninsula.
- Report to Environment Australia on TSN grant for work on Burrup Peninsula.
- Analysis of diet samples and morphometric data for publications on ecology and taxonomic description.
- Regional survey of Pilbara (with Nickol Bay Nats. Club) to determine distribution and conservation status of species.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Implementation of the Lancelin Island skink Recovery Plan

SPP # 1999/0011

Team member

D Pearson (0.1), Perth Zoo - captive breeding; Total (0.1).

Aim

To ensure the survival of the Lancelin Island skink through strategic research, monitoring and translocation of the species as outlined in its Recovery Plan (Pearson and Jones 1997).

Summary of progress

- The Lancelin Island skink is known only from Lancelin Island (7.6 ha) and a single location on the adjacent mainland. Further surveys have failed to find any other individuals on the mainland.
- Two translocations undertaken to Favourite Island (total 90 skinks) after 12 months monitoring of the existing lizard populations. First translocation of a lizard in WA and one of the few translocations of reptiles worldwide.
- Ongoing collaborative work with Perth Zoo in maintaining captive colony (monitoring condition, selecting breeding stock, measuring and sexing neonates and selection of individuals for translocation).
- Reports on progress of Lancelin Island Skink Recovery Team provided to Dennis Hockey and Corporate Executive.

Future direction(s)

- Monitoring of Favourite Island translocated population and Lancelin Island population in Dec 2003 and March 2004. Further release of captive-bred skinks and direct transfer of Lancelin Island wild stock proposed for Dec 2003.
- Publication of results of captive breeding and translocation to Favorite Island.
- Report to Recovery Team and Corporate Executive.
- Supervision of student (Z Hamilton, UWA) examining genetics of sympatric skinks on Jurien Bay islands.
- Analyse collected genetic material to examine reproductive dynamics of captive colony.

DCLM Region

Midwest.

IBRA Region

Geraldton Sandplains.

Breeding ecology and conservation of the Banded stilt

SPP # 1999/0013

Team members

J Lane, G Pearson, A Clarke; Total (0.0).

Aim

- To identify principal breeding locations of Banded stilt in Western Australia.
- To develop improved understanding of breeding biology.
- To quantify factors governing breeding success.
- To identify threats.
- To disseminate knowledge to ensure conservation.

Summary of progress

- No field work was undertaken during 2002-03, due to annual rainfall in Eastern Goldfields being insufficient to warrant aerial inspections for Banded stilt breeding activity.
- Report on previous breeding activity was not prepared, due to priority being given to other work.

Future direction(s)
- Rainfall reports from the Eastern Goldfields (main breeding range of Banded stilt in WA) will be monitored.
- Following exceptional rainfall events and reports of flooding, aerial surveys will be conducted to locate and monitor breeding colonies.
- Colonies will be photographed from the air and, if feasible, visited on the ground to determine number of breeding pairs, nesting and fledging success, water depths, water chemistry and food availability.
- Chicks will be banded and leg-flagged to obtain information on movements and longevity.
- A report on previous breeding activity will be prepared.

DCLM Region
Goldfields.

IBRA Region
Murchison.

Ground parrot recovery
SPP # 2000/0002

Team members
A Burbidge (0.05), J Rolfe (0.02); Total (0.07).

Aim
- To develop an understanding of habitat requirements, including response to fire.
- To create management prescriptions that will increase the survival chances of the Ground parrot and increase its total population size.

Summary of progress
- All contemporary and historical records brought into a digital environment, for use in a GIS, to facilitate planning of specific management actions.
- In collaboration with regional staff, discussion paper developed concerning fire management at Waychinicup–Manypeaks.
- In collaboration with regional staff, options have been developed for fire management for the major population in Fitzgerald River NP.
- Monitoring at Cape Arid NP has led to the rediscovery of the species at this location.
- NHT funding proposal developed in collaboration with regional staff; high likelihood of being funded.

Future direction(s)
- Validate accuracy of all location records using GIS framework.
- Develop monitoring protocol.
- Analyse data from monitoring program.
- Write Recovery Plan.
- Implement Recovery Plan where funds permit (including monitoring and a trial translocation).

DCLM Region(s)
South Coast, Warren.

IBRA Region(s)
Esperance Plains, Jarrah Forest, Warren.

Probait trials: phase 2
SPP # 2000/ 0014 (includes 99/ 0018)

Team members
N Marlow (0.35), A Williams (0.4); Total (0.75).

Aim
- To determine the field longevity of the new fox bait 'Probait'.
- To investigate the risk of Probaits (if any) to non-target fauna.
- To undertake uptake trials of the optimal bait type (when it is identified).

Summary of progress
- Field uptake trials completed and report written.
- Non-target testing completed and manuscript published.
- Field longevity trials completed, data analysis complete, report writing underway.

Future direction(s)
- Field trials to be undertaken to establish the influence of different binders on bait longevity and odour.
- Field trials to determine increased uptake of baits (if any) when different flavour enhancers are added.
- Field trial to determine the relative uptake of the optimum bait type (as defined by the results of the binder and flavour enhancer field trials) in comparison with dried meat baits.

DCLM Region(s)
Goldfields, Wheatbelt, Warren, South West.

IBRA Region(s)
Avon Wheatbelt, Jarrah Forest, Coolgardie, Warren.

Monitoring of mammal populations on Barrow Island

SPP # 2000/0012

Team members
K Morris (0.05), A Burbidge (0.05), Regional staff - G Kregor; Total (0.1).

Aim
To establish and implement a monitoring protocol for native and introduced mammals on Barrow Island. This information gathered will be used by DCLM and ChevronTexaco (the oil field operators on Barrow island) to measure significant changes in abundance of the native species and to detect the presence of exotic species. The islands around Barrow Island, which once supported black rats, are also monitored.

Summary of progress
- Field work undertaken in Oct 2002.
- Detailed analysis of 30 yrs of spotlighting data undertaken using DISTANCE 3.5 software.
- Report prepared and distributed Feb 2003.
- Input into the Department's submission on the Environmental, Social and Economic assessment of the proposed Gorgon gas field development.
- Publication of a paper on the black rat eradication program on Barrow Island.

Future direction(s)
- Mammal monitoring in Oct 2003
- Commencement of PhD project on the taxonomy and social structure of the Boodie on Barrow Island.
- More detailed analysis of mammal trapping data.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Population dynamics of rare arid zone dasyurids; improving knowledge for monitoring and management

SPP # 2001/0002

Team members
D Pearson (0.3), A Williams (0.2); Total (0.5).

Aim
To examine the population fluctuations of 3 dasyurid species which occur on mineral leases in the north-eastern Goldfields and to determine the relative influence of seasonal conditions (rainfall), vegetation change and predation on population structure, dispersal and core habitat usage.

Summary of progress
- Monitoring in June, July and Aug 2002 and April 2003. Trapping success very poor due to very dry conditions.
- Surveys for further populations of Mulgaras and other threatened dasyurids failed to locate other viable populations.

Future direction(s)
- Ongoing monitoring of Mulgara populations at Mt. Keith. Survey of other possible study sites at Leinster.
- Radio-telemetry of Mt Keith Mulgaras. Trialling of automated system to examine burrow use.

DCLM Region
Pilbara.

IBRA Region
Pilbara.

Status and ecology of the Heath mouse (*Pseudomys shortridgei*) in Western Australia

SPP # 2003/0001

Team members
B Johnson (0.3), K Morris (0.05), PhD student - D Cancilla; Total (0.35).

Aim
- To determine the distribution, taxonomy and conservation status of the Heath Mouse.
- To examine the species' population dynamics and habitat relationships.
- To study the species' ecology with a view to identify potential threatening factors.
- To use predictive models to locate and examine new populations.
- To facilitate the involvement of post-graduate studies.

Summary of progress
- Links with industry (BHP Billiton) and tertiary institution (Murdoch) established.
- Literature review completed, bibliography established.
- Historical sites resurveyed in Fitzgerald RNP/Ravensthorpe area.
- Site for population studies established at Lake Magenta Nature Reserve.
- Preliminary genetic analysis completed – east and west populations appear to be the same taxon.

Future direction(s)
- Ongoing ecological studies: mark-recapture trapping, radiotelemetry, refuge sites, habitat requirements.
- Investigate population dynamics.
- Predictive modeling of occurrence.
- Survey of predicted sites of occurrence.

DCLM Region(s)
Wheatbelt, South Coast.

IBRA Region(s)
Mallee, Esperance Plains.

Return to Dryandra

SPP # 2003/0002

Team members
N Thomas (0.5), N Marlow (0.25); Total (0.75).

Aim

- To provide a scientific basis for the establishment and maintenance of breeding populations of at least 5 CWR threatened marsupial species (Dalgyte, Boodie, Marl, Mala and Merrnine) from remote areas in large enclosures at Dryandra.
- To establish self-sustaining populations of these CWR threatened marsupial species within enclosures at Dryandra.
- To compare the success of different release and reintroduction methodologies and to develop optimal strategies for these CWR threatened marsupial species within Dryandra Woodland.
- To establish self-sustaining populations of these re-introduced CWR threatened marsupial species within Dryandra Woodland.

Summary of progress

- Populations of the 5 species established within Dryandra enclosure.
- Regular monitoring of 4 species' populations within the enclosure at 3-monthly intervals and extra monitoring for Mala carried out. Merrnine monitoring methods using battue developed.
- Viable populations of Mala, Dalgyte, Marl and Boodie established. Merrnine are established and breeding but have been reduced to small numbers through predation by Wedge-tailed eagles.
- Dalgytes have been reintroduced into Dryandra Woodland proper and monitoring is continuing. Food availability appears to be adequate and Dalgytes have bred since release. Within the Woodland, Dalgytes have been prey to Carpet pythons and large raptors (Masked owl?). Dalgytes that have left the Woodland after release have been taken by foxes and feral cats.
- A proposed release of Marl in 2000 was postponed pending investigations of disease conditions found in captive and island populations. This investigation is continuing.
- The Boodie and Dalgyte populations inside the enclosure are breeding well.
- Construction of Barna Mia, a 4 ha predator-proof interpretive centre completed Oct 2002. Trapping of suitable RTD species for release into Barna Mia carried out.
- Landscope article published.
- Report to Western Shield committee Aug 2001 and July 2002.
- Marl disease workshop organized for July 2002.
- SPP written and submitted.
- Article on Marl for publication in Landscope written.
- Boodie TP written.

Future direction(s)

- Boodie translocation carried out into Dryandra Woodland proper in spring 2003 and radio-tracking/ monitoring carried out. Top up releases of Boodies into Dryandra Woodland, if required, by spring 2004.
- Undertake survey within Dryandra Woodland for surviving colonies of Dalgytes. Top up release of Bilbies into Dryandra Woodland by autumn 2004, monitored using tail transmitters.
- Development of trapping techniques and protocols for monitoring Dalgytes and Boodies outside RTD enclosure.
- During 2003, source additional Marl, Mala and Merrnine for top up release into RTD enclosure. Radio-tracking of Marl, Mala and Merrnine in enclosure to establish cause of mortality. Develop research program on the specific requirements for breeding sufficient numbers for release.
- Marl translocation carried out into Dryandra Woodland proper and radio-tracking/ monitoring carried out

by spring 2004. Development of trapping techniques and protocols for monitoring Marl outside RTD enclosure.
- Mala TP for Dryandra Woodland to be completed and submitted by end 2003. Mala translocation carried out into Dryandra Woodland proper and radio-tracking/monitoring carried out by spring 2004. Development of trapping techniques and protocols for monitoring mala outside RTD enclosure. Top up release of Mala by spring 2005 if required.
- Merrnine TP for Dryandra Woodland to be completed and submitted by end 2004. Merrnine translocation carried out into Dryandra Woodland proper by spring 2005. Development of trapping techniques and protocols for monitoring merrnine outside RTD enclosure.
- During 2004 determine feasibility and carry out a trip to Dorre Island to capture Boodies and Merrnine to augment numbers in the RTD enclosure.
- Report to WSSWMC to be completed and submitted annually.

DCLM Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

Development of effective broad-scale aerial baiting strategies for the control of feral cats

SPP # 2003/0005

Team members
D Algar (0.9), J Angus (0.9), M Onus (0.9), N Hamilton (0.9); Total (3.6).

Aim
Control of feral cats is recognized as one of the most important conservation issues in Australia today. Broad-scale baiting offers the best option to control feral cats in strategic areas and is seen as the method most likely to produce an effective operational method for cat control. Development of an effective baiting technique for the control of the feral cat is cited as a high priority by the national Threat Abatement Plan for Predation by Feral Cats. DCLM researchers have designed and developed a bait medium that is attractive to feral cats and effective in controlling them on a localized scale. This bait medium has been employed as an integral part of successful island cat eradication programs off the Western Australian coast. The program, in progress, is aimed at developing optimal broad-scale control programs for feral cats. A number of key factors are being researched to provide an effective broad-scale aerial baiting strategy for feral cats.
- To examine bait uptake in relation to the time of year to enable baiting programs to be conducted when bait uptake is at its peak and therefore maximize efficiency.
- To examine baiting intensity (number of baits laid/km^2) in relation to baiting efficiency to optimize control.
- To examine baiting frequency (number of times/yr or yearly intervals) required to provide sustained effective control.

In addition to optimising the various parameters of baiting programs, research is also being conducted:-
- To assess the potential impact of baiting programs on non-target species populations and devise methods to reduce the potential risk where possible.
- To provide scientific validation of the Track Density Index (TDI) as a reliable estimate of relative cat abundance. The technique initially is required to provide an objective assessment of baiting frequency.

Summary of progress
- Research into bait uptake in relation to the time of year has been completed. This research in the interior arid zone has suggested that the optimum time to conduct baiting programs and maximize their effectiveness is under cool dry conditions in winter. At this time, the abundance and activity of all prey types, in particular small mammals, reptiles and birds, is at its lowest and bait degradation due to ants and to hot, dry weather, is significantly reduced.
- A series of ongoing trials are investigating baiting efficacy at differing bait distribution rates to provide a cost-efficient control strategy. To-date, this series has demonstrated that a baiting density half that used

in island eradications is equally efficacious in the control of feral cats in the arid interior. This evidence has been supported by a highly effective toxic baiting of feral cats on the Gibson Desert Nature Reserve and Peron Peninsula. The high level of control of feral cats during these exercises suggests that further reductions in bait distribution are likely to be equally efficacious.
- Assessing the impact of baiting programs on a number of non-target species potentially at risk has commenced.
- Examination of the Track Density Index as a reliable estimate of relative cat abundance has commenced.

Future direction(s)
- Conduct further research to optimise the various parameters of baiting strategies.
- A comprehensive risk assessment of the potential impact of feral cat baiting programs on populations of non-target species is continuing, and where necessary, methods devised to reduce this risk. This risk assessment is required to gain National Registration Authority registration of the bait as well as assuring the protection of native fauna.
- Further development into the technique to efficiently and reliably census feral cat populations.

These research areas will enable the provision of an effective cat control strategy to protect either extant fauna or reintroduced fauna across the State's semi-arid and arid bioregions especially.

DCLM Region(s)
Research into optimising baiting strategies is being conducted principally in the Midwest and Goldfields. Assessment of the potential bait risk to non-target species is of necessity being undertaken opportunistically across Regions.

IBRA Region(s)
Research into optimising baiting strategies is being conducted principally in the Murchison, Carnarvon and Gascoyne. Assessment of the potential bait risk to non-target species is of necessity being undertaken opportunistically across Murchison, Carnarvon, Gascoyne.

FLORA RECOVERY AND CONSERVATION

Acacia biology, conservation and utilization
SPP # 2002/0008

Team member
B Maslin (0.5); Total (0.5).

Aim
To undertake research to provide taxonomic and other advise to enable the effective utilization of *Acacia* for nature conservation and applied purposes.

Summary of progress
- SPP for this project completed.
- AcaciaSearch report completed (to be published by RIRDC in 2003): a report on crop potential of southern Australian acacias as an aid to salinity control.
- *Acacia microbotrya*: field work completed; morphometric analysis of variation undertaken (with N Gibson); taxonomic elucidation in progress and scientific paper commenced.
- *Acacia saligna*: provisional taxonomy of the complex completed (provides basis for genetic investigation under M Byrne's direction); field survey undertaken (including identification of populations suitable of seed collection for on-farm trials by Farm Forestry team).
- Curation of Herbarium *Acacia* collections commenced (as basis for re-assessment of conservation status of the WA taxa).

Future direction(s)
- Complete write-up of *A. microbotrya* project.

- Progress taxonomic elucidation of *A. saligna* group.
- Commence reassessment of conservation status of W.A. *Acacia* flora.
- Attend Symposium in Melbourne (Sept 2003): Co-organize the *Acacia* session focusing on taxonomy of *Acacia*. Take this opportunity to do limited field work necessary to complete taxonomic revision of *Acacia verniciflua* work (with D Murphy, Melbourne University).

DCLM Region
All.

IBRA Region
All.

Pilbara Regional Herbarium

Core Function

Team members
S van Leeuwen (0.05), B Bromilow (0.15); Total (0.2).

Aim
To curate the Pilbara Regional Herbarium. This aim includes maintenance of the collection with respect to the condition of vouchers; maintenance of the facility with respect to the building, air conditioners, dehumidifiers and voucher storage infrastructure; maintenance and development of the specimen database; and the curation of the specimen vouchers to ensure that identifications are correct and current and that contemporary taxonomic nomenclature is applied.

Summary of progress
- Current holdings in the Pilbara Regional Herbarium are 9 500 vouchers.
- Incorporation of over 2 000 additional vouchers in past 12 months.
- Major collections incorporated from the Botanical Survey of Hamersley Range Uplands, Meentheena LANDSCOPE expeditions, supplementary expeditions to the Biological Survey of the south-western Little Sandy Desert and the Botanical Survey of Hamersley Range Tussock Grasslands.
- Taxonomic specialists at eastern state herbaria curated *Centipeda, Convolvulus, Polymeria* and *Bonamia* holdings.
- Major repairs to air conditioning system and dehumidifier unit were undertaken.
- Advice provided to Juluwarlu Language Centre in Roebourne in respect to plant identifications, taxonomic name and ethnobotanical knowledge of select taxa used by the Ngaluma Injbandi people.
- Reference collection of 1 200 vouchers was augmented through the addition of 170 new records.
- Reference collection was extensively used by Astron Environmental, Hamersley Iron and environmental consultants employed by Main Roads Western Australia.

Future direction(s)
- Incorporation of supplementary specimens from the Biological Survey of the south-western Little Sandy Desert, Biological Survey of the Barlee Range Nature Reserve and the 'Exploring Barlee' LANDSCOPE Expeditions (2002).
- Incorporation of rare and priority flora collection provided by Hamersley Iron.
- Expert curation of Papilionaceae holdings by specialist in the Northern Territory (DNA) and Queensland (BRI) herbaria.

Confirmation of identification of Declared rare flora and Priority flora voucher specimens and identifications for nature protection operations

Core Function - Herbarium curation and Nature Protection Operations

Team members
S Patrick (0.05); Total (0.05).

Aim
To ensure that voucher specimens for new populations of Declared Rare Flora are correct, so that requirements of the Wildlife Conservation Act can be applied correctly, and to ensure that vouchers of Priority Taxa are correctly named in order to assist District and Regional Conservation Officers in survey work for priority taxa. Identifications for Nature Protection Operations for breaches of the Wildlife Conservation Act.

Summary of progress
- 125 vouchers of Declared Rare Flora confirmed or re-identified.
- 99 vouchers of Priority taxa confirmed or re-identified.
- 6 letters to Nature Protection Operations with identification of 38 specimens.

Future direction(s)
- Continue working on backlog of 55 Declared Rare and 178 Priority specimens.
- Identify and report on specimens brought in by Nature Protection Operations as required.

DCLM Region(s)
Midwest, Wheatbelt, South Coast, Swan, South West, Warren, Pilbara.

IBRA Region(s)
Avon Wheatbelt, Carnarvon, Gascoyne, Geraldton Sandplains, Great Sandy Desert, Jarrah Forest, Pilbara, Swan Coastal Plain, Warren.

Integrated strategies for the control of *Phytophthora cinnamomi* using phosphite

SPP # 93/0068

Team members
B Shearer (0.5), C Crane (0.5); Total (1.0).

Aim
To understand the effectiveness of phosphite against *P. cinnamomi* in native flora for long-term control of the pathogen

Summary of progress
- Obtained funding from NHT in 2001/02 to determine factors affecting effectiveness and persistence of phosphite for the control of *P. cinnamomi* in threatened communities.
- Site had a minor influence on phosphite effectiveness despite large differences in soil nutrient status between sites.
- Plant age was a major influence on phosphite effectiveness. Low-volume phosphite application was more effective in woody tissue of older plants than in non-woody tissue of seedlings.
- Plant species was a major influence on phosphite effectiveness. Plant species could be grouped into either phosphite non-responsive, such as *Lambertia inermis,* and phosphite responsive, such as *Banksia grandis.*
- Application method did not overcome ineffectiveness of phosphite in *L. inermis*.

Future direction(s)
- Determine plant species differences in phosphite effectiveness in order to build a database of species belonging to either phosphite effective or non-effective groups.
- Determine inter-specific differences in phosphite effectiveness within *Lambertia* in order to better protect rare and endangered *Lambertia* species currently being treated with phosphite, but dying from *P. cinnamomi* infection.

DCLM Region(s)
South West, South Coast.

IBRA Region(s)
Esperance Plains, Jarrah Forest, Swan Coastal Plain.

Weeds of Western Australia: advice, liaison, publicity and documentation

SPP # 1997/0002

Team members
G Keighery (0.3), W Muir (0.1); Total (0.4).

Aim
To assist with the documentation of the occurrence, impact and control of environmental weeds of Western Australia.

Summary of progress
- 5 new exotic weeds recorded as established in Western Australia (*Aeonium arboreum*, *Iris laevigata*, *Portulacaria afra*, *Salix humboltiana* and *Salix matsundana*).
- New Western Australian native species recorded as environmental weeds (*Callistemon phoenicus*, *Leptospermum sericeum*, *Pittosporum angustifolium*, *Eucalyptus calophylla* X *ficifolia*).
- New garden escapes (*Chlorophyton comosum*, *Oenthothera* rosea) documented.
- Keynote address on 'Bulbous Weeds of Western Australia', EWAN Workshop, March 5, 2003
- New edition of field guide 'Western Weeds' printed.

Future direction(s)
- Complete survey of SW arboreta for naturalizing populations.
- Continue advice on weeds weed issues ranging from targets for biological control, potential weeds for Environmental protection, provenance of plantings and proposed rehabilitation subjects for Regional Parks.
- Continue on WONS Steering Group for Bridal Creeper, ANZEEC Group for weeds of conservation concern and reviewing Rottnest weed and rehabilitation plans.
- Publish weed checklist.

DCLM Region(s)
All.

IBRA Region(s)
All.

Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora

SPP # 1998/0003

Team members
M Byrne (0.4), D Coates (0.3), B Macdonald (0.4); Total (1.1).

Aim
To provide genetic information for the conservation and management of Western Australian flora, particularly rare flora, in particular to resolve the possible hybrid status of *Eucalyptus bennettiae*, *Adenanthos cunninghamii* and *Grevillea phanerophleba*; to determine the phylogenetic relationships between geographically diverse populations of *Grevillea althoferofum*, resolve the systematic position of *E. delicata*, and to determine the taxonomic status of species in the *E. angustissima* and *E. kochii* complexes.

Summary of progress
- *E. bennettiae* – analysis with microsatellite loci has confirmed the status of both populations as a hybrid between *E. sporadica* and *E. lehmannii*.
- *A. cunninghamii* – analysis with AFLP markers is consistent with both populations of *A. cuninghamii* being a hybrid between *A. cuneatus* and *A. sericeus*. Progeny of *A. cunninghamii* are not within the

morphological taxonomic limits of the species.
- *G. phanerophleba* – microsatellite loci assays of plants from *G. phanerophleba* and the putative parents *G. amplexans* and *G. biternata* from 2 locations have been completed and are being analysed.
- *G. althoferorum* – trials of microsatellite reaction conditions are being carried out to obtain suitable markers to investigate the taxonomic relationship of the 2 populations.
- *E. delicata* – analysis of populations of *E. delicata*, *E. salmonophloia* and *E. longicornis* shows that *E. delicata* is related to *E. longicornis* and should be placed in the Subulatae series.
- *E. angustissima* ssp. *quaerenda* – taxonomic revision to species rank has been completed.
- *E. kochii* complex – taxonomic revision of the complex has been completed with revision of *E. plenissima* and *E. horistes* to subspecies of *E. kochii*.

Future direction(s)
- Work on *G. phanerophleba* will be completed to resolve its putative hybrid status.
- Analysis of *G. althoferofum* will be completed to determine the taxonomic relationship of the populations.
- The extent of clonality in the Brookton populations of *D. ionthocarpa* will be investigated.
- The genetic relationship between *Adenanthos eyrei* and *A. forrestii* will be investigated to determine the taxonomic status of *A. eyrei*.

DCLM Region(s)
South Coast, Midwest, Swan, Wheatbelt.

IBRA Region(s)
Geraldton Sandplains, Esperance Plains, Swan Coastal Plain, Avon Wheatbelt, Yalgoo, Coolgardie, Mallee, Murchison.

WATTLE: a computer-based information system for the genus *Acacia*
SPP # 1999/0005

Team member
B Maslin (0.1); Total (0.1).

Aim
To produce an electronic identification key and information delivery system for Australian species of *Acacia*.

Summary of progress
- Significant data for inclusion in WATTLE assembled through the AcaciaSearch project; results of this project to be published as a book by RIRDC in 2003.
- Stabilization of the name *Acacia* being sought through a formal proposal to retypify *Acacia* with an Australian type: paper accepted for publication in international journal Taxon.

Future direction(s)
- Develop data input/maintenance procedures via the new Lucid ver. 3 software (to be undertaken as part of the Wattles of the Pilbara project).
- Incorporate AcaciaSearch data into WATTLE.
- Assemble new WATTLE data via Pilbara and Dalwallinu Wattle projects.
- Deliver seminars & workshops on use and functionality of WATTLE.

DCLM Region(s)
All.

IBRA Region(s)
All.

Seed biology, seedbank dynamics and collection and storage of seed of rare and threatened Western Australian taxa

SPP # 1999/0010

Team members

A Cochrane (1.0), A Crawford (1.0), D Coates (0.05); Total (2.05).

Aim

- To provide a cost effective and efficient interim solution to loss of floral genetic diversity.
- To provide a focus for flora recovery in Western Australia.
- To ollect and store seed of rare and threatened Western Australian plant species.
- To determine the germination and storage requirements of seed.
- To monitor the viability of stored seed over the long term.
- To increase knowledge of seed biology using both field and laboratory based studies.
- To describe and categorize seed and gather phenological data.
- To incorporate all information into a corporate database (WASEED).
- To provide relevant information on seed availability, seed biology, storage requirements and viability of seed of rare and threatened taxa to assist the development of management prescriptions and preparation of Interim Recovery Plans and Translocation Plans.

Summary of progress

- Seed collections from more than 186 rare, threatened and poorly known taxa were made (209 accessions). This included 52 DRF, 130 Priority and 27 general collections.
- All data pertinent to the collection, testing, storage and monitoring of seed-based data has been entered into the WASEED database, which is presently undergoing some updates.
- TFSC staff attended a Native Seed Dormancy Master Workshop in Perth (Aug 5-6, 2002).
- A project to investigate seedbank dynamics and response to disturbance of the critically endangered *Grevillea maxwellii* was completed with Bankwest *Landscope* Visa Conservation Card funds and a report written.
- A project to investigate seedbank dynamics and response to disturbance of the critically endangered *Dryandra ionthocarpa* has been initiated (April 2003) with Bankwest *Landscope* Visa Conservation Card funds.
- A paper was presented to the conference *Prospects for Biodiversity Conservation in Rivers and Salinising Landscapes* in Albany, Western Australia on 21-25 Oct 2002, entitled '*Ex situ* germplasm conservation as a means of biodiversity conservation in salinising landscapes'.
- Two papers were published.
  Cochrane, A., Brown, K. and Kelly, A. 2002. Low temperature and low moisture storage of seeds of rare and threatened taxa in the endemic Western Australian genus *Dryandra* (R. Br.) (Proteaceae) *Conservation Science Western Australia* 4 (1), 1–12.
  Cochrane, A. Brown, K. and Kelly, A. 2002. Low temperature and low moisture storage of seed of the endemic Australian genus *Eremophila* R. Br. (Myoporaceae). *Journal of the Royal Society of Western Australia* 85 (1), 31-35.

Future direction(s)

- Ongoing collection of seed for incorporation into the genebank, including DRF and priority taxa, and common species associated with threatened ecological communities.
- Ongoing research into the seed biology and seed storage behaviour of a number of critically endangered plant taxa.
- Germination testing, storage and monitoring of existing accessions.
- Reporting requirements to NHT, MSBKew and Bankwest *Landscope* Visa Conservation Card Trust Fund.
- Articles and a book chapter for publication.
- Collaborative work with DCLM Narrogin Nursery on seed germination requirements.

DCLM Region(s)

All.

IBRA Region(s)
Avon Wheatbelt; Carnarvon, Coolgardie, Esperance Plains, Gascoyne, Geraldton Sandplains, Great Sandy Desert, Hampton, Jarrah Forest, Mallee, Murchison, Nullarbor, Swan Coastal Plain, Warren, Yalgoo.

Susceptibility of rare and endangered flora to *Phytophthora*

SPP # 1999/0019

Team members
B Shearer (0.5), C Crane (0.5); Total (1.0).

Aim
- To determine variation in susceptibility to *P. cinnamomi* between and within families.
- To identify within species variation in susceptibility.
- To rank taxa according to susceptibility to identify those at risk.

Summary of progress
- Tested 70 taxa for susceptibility in 2003.
- To date 40+ taxa transferred to pots for testing in 2004.
- Database of 200 + taxa updated.
- Provisional susceptibility list distributed within DCLM.
- Presentations of progress given to South Coast and Central Regions.

Future direction(s)
- Plant up germinates as received from Threatened Species Seed unit throughout 2003/04.
- Inoculate plants in 2004 and record mortality.
- Update database.
- Test survivors for root infection.
- Test *Lambertia* species for within species variation in susceptibility.

DCLM Region(s)
Midwest, Swan, Wheatbelt, South West, Warren, South Coast.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren.

Confirmation of the conservation status of rare and poorly known flora thought to be endangered or critically endangered

SPP # 1999/0020

Team members
S Patrick (0.5), L Polomka (1.0); Total (1.5).

Aim
To accurately assess the conservation status of Western Australian flora listed as poorly known but considered to be rare (DCLM Priority Flora.) Approx. 200 taxa have been targeted for survey after assessment for those most likely to be critically endangered.

Summary of progress
- Survey work has been undertaken in 3 DCLM Regions.
- 44 taxa have been targeted for survey, with an increase of 45 known populations.
- 8 taxa have been recommended for gazettal as rare, of which 5 are recommended as critical and 3 as endangered.
- As a result of survey 12 of the target taxa have been recommended for downgrade on the Priority list.
- 38 new populations of 22 other poorly known taxa have been surveyed.
- 2 *Landscope* Expeditions to the Midwest and Gascoyne Regions have furthered work on Priority taxa in those areas.

Future direction(s)

- 6 taxa have been highlighted for recommendation for gazettal as rare after a small amount of further survey in the 2003 flowering season.
- Further survey is required on approx 120 taxa not yet targeted.
- The list of target taxa requires revision in relation to new taxa added in the most recent Priority List of May 2003.
- One *Landscope* Expedition through MidWest Aug/Sept 2003 to survey Priority taxa.

DCLM Region(s)
Midwest, Wheatbelt, Swan, South West, Warren, South Coast.

IBRA Region(s)
Avon Wheatbelt, Carnarvon, Esperance Plains, Gascoyne, Geraldton Sandplains, Great Sandy Desert, Jarrah Forest, Mallee, Murchison, Pilbara, Swan Coastal Plain, Warren, Yalgoo.

Wattles in the Shire of Dalwallinu

SPP # 2000/0013

Team member
B Maslin (0.2); Total (0.2).

Aim
To research and promote *Acacias* of the Dalwallinu Shire through (1) publication of a book (field guide) and scientific papers; (2) conducting an Acacia Symposium in Dalwallinu, (3) developing an *Acacia* website (called WorldWideWattle) and (4) participating in the creation of an Environmental Interpretive Centre in Dalwallinu.

Summary of progress
- Published proceedings of the Dalwallinu Acacia Symposium (*Conservation Science Western Australia* 4(3): 1-191); author of 2 papers.
- Commenced construction of WorldWideWattle website. Site design completed; design implementation in progress (by relevant Herbarium staff); information content being assembled.
- Attended planning meetings relating to the Dalwallinu Environmental Interpretive Centre.

Future direction(s)
- WorldWideWattle: complete phase 1 and implement second phase of project (which will include improved design features and functionality).
- Dalwallinu Environmental Interpretive Centre: attend planning meetings; provide input into displays in relation to *Acacia*.
- Progress field guide to Acacias of the Dalwallinu Shire.

DCLM Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance

SPP # 2001/01

Team members
D Coates (0.4), M Byrne (0.1); Total (0.5).

Aim
- To assess the relationship between effective population size and levels of genetic diversity, and the minimum effective population size for maintaining genetic diversity.
- To assess the effects of population size and habitat degradation on mating system parameters that indicate inbreeding or the potential for inbreeding.

- To assess whether reduction in population size, increased inbreeding and reduced genetic variation are associated with any reduction in fitness.
- To assess whether there are differences in the levels of genetic diversity and mating system between rare and common congeners, which provide a more general understanding of rarity in this flora and how it can be managed.

Summary of progress
- Paper published in Conservation Science Western Australia (Buist, Coates and Yates) on 'Rarity and threat in relation to the conservation of *Acacia* in Western Australia'.
- Paper in press in American Journal of Botany on 'Evolutionary patterns and genetic structure in rare and widespread species in a triggerplant (*Stylidium caricifolium*: Stylidiaceae) species complex'.
- Draft paper finalized on 'Genetic divergence among and population genetic structure within 2 rare *Banksia* species and their common close relative in the *Banksia* subgenus *Isostylis* R.Br. (Proteaceae)'.
- Draft paper prepared on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis ssp. Fimbrilepis*'.

Future direction(s)
- Finalize paper on population genetic structure and the mating system of the rare ghost wattle, *Acacia sciophanes* and its common congener *Acacia anfractuosa.*
- Complete temporal mating system data analysis on *B. cuneata.*
- Commence mating system studies on *Banksia oligantha.*

DCLM Region(s)
Wheatbelt, Midwest, Swan, South West, South Coast, Warren.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren.

Experimental translocation of critically endangered plants

SPP # 2001/0004

Team members
L Monks (1.0), D Coates (0.1); Total (1.1).

Aim
- To develop appropriate translocation techniques for a range of critically endangered flora.
- To develop detailed protocols for assessing and predicting translocation success.
- To establish a translocation database for all threatened plant translocations in Western Australia.

Summary of progress
- 16 translocations planted in previous years were monitored.
- Undertook further planting at 5 current translocation sites.
- Set up one new translocation site.
- 5 new proposals for translocations of critically endangered flora were prepared.
- Development of flora translocation database continuing.
- Completed lab work for mating systems study on Lambertia orbifolia translocation and commenced data scoring.
- Attended the Australian Network for Plant Conservation conference in Geelong. Organized and ran a workshop on threatened flora translocations.
- Invited author for the revision of the Australian guidelines for threatened flora translocations.

Future direction(s)
- Continued planting of experimental translocations of 16 critically endangered plant species where further planting's are deemed necessary.
- Planting of 5 new translocations of critically endangered flora planned for winter 2003. Including 2 translocations undertaken in partnership with the Corrigin LCDC.
- Continued monitoring of the 16 current and 5 new translocations and analyses of population biology

data.
- Publication of translocation methodology data and Lambertia orbifolia mating systems study.
- Finalize development of rare flora translocation database.
- Study trip to the USA to visit flora translocation specialists in Oregon, to discuss translocation techniques and theory and visit translocation sites.

DCLM Region(s)
Midwest, South Coast, South West, Wheatbelt.

IBRA Region(s)
Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren.

Genetic and ecological viability of plant populations in remnant vegetation

SPP # 2002/0001

Team members
D Coates (0.3), M Byrne (0.1), C Yates (0.2), R Fairman (0.5), C Elliott (1.0); Total (2.1).

Aim
- To identify and quantify the genetic and demographic factors that affect the viability of plant populations in vegetation remnants. The focus will be on the effects of genetic erosion, inbreeding and pollinator limitation on seed production and seedling fitness. This will involve the integrated use of molecular genetic tools and demographic monitoring to examine 4 target taxa with varied ecologies.
- To examine and model the relationships between key genetic and demographic factors affecting viability and remnant vegetation characteristics such as size, disturbance and landscape position.
- To compare results among 3 target taxa with varied ecologies to assess how life history affects the impact of remnant characteristics on population viability.
- To develop specific genetic and demographic guidelines for management of remnant populations of the 3 target taxa and general landscape design principles for major plant life history types that will maximize the probability of population persistence.

Summary of progress
- Completion of analysis of site/population characteristics – disturbance and density.
- Completion of genetic variation studies covering all populations of *C. quadrifidis* and *E. wandoo*
- Commencement of microsatellite marker development for *E. pauciflora* and *C. quadrifidis* for gene flow studies.
- Completion of seed set/reproductive output analysis for year 1 for *C. quadrifidis* and *E. wandoo.*
- Commencement of growth/fitness trial experiments for *C. quadrifidis* and *E. wandoo*.
- Commenced preparation of publication on genetic variation and reproductive output in fragmented populations of *Eremaea pauciflora*.
- Year 2 assessment of seed production in *E. pauciflora* commenced.
- Year 2 sampling for seed production and flowering phenology in *C. quadrifidus* and *E. wandoo* completed.
- Milestone report for project in preparation with CSIRO for submission to Land and Water Australia
- PhD scholarship awarded to C Gage for *Eremaea* work.

Future direction(s)
- Complete of analysis of site / population characteristics in relation to connectivity and isolation.
- Complete of microsatellite marker development for *E. pauciflora* and *C. quadrifidis.*
- Commence gene flow studies in all 3 species.
- Commence mating system studies on *E. pauciflora* and *C. quadrifidis.*
- Completion of seed set / reproductive output analysis for year 2 for *C. quadrifidis* and *E. wandoo.*
- Completion of growth/fitness trial experiments for all 3 species.
- Submit for publication paper on genetic variation and reproductive output in fragmented populations of *Eremaea pauciflora*.
- Prepare and submit final milestone report to Land and Water Australia.

- Prepare case with CSIRO for continuation of work for at least 2 further years with additional species to be targeted.

DCLM Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

Declared rare and poorly known flora in the Goldfields region, wildlife management program

SPP # 2003/0007

Team member
S Patrick (0.3); Total (0.3).

Aim
To provide a source of current information on all Rare and Priority taxa in the Goldfields Region, with management and research actions listed for each taxon.

Summary of progress
- All populations listed, with dates of inspections, number of plants, and condition of populations for all 77 Priority One taxa.
- Priority One taxa information sent to the Goldfields Regional Ecologist for fieldwork during flowering season.
- Species information updated for new taxa added to list and information passed to Goldfields Region.

Future direction(s)
- Add information to files and manuscript account for all new taxa added to Priority List 2003.
- Write up accounts for all taxa and other parts of the Management Plan.
- List all populations, with dates of inspections, number of plants, and condition of populations for all 44 Priority Two taxa.
- Send Priority Two taxa information to the Goldfields Regional Ecologist for fieldwork during flowering season.
- Arrange fieldwork in the Region.

DCLM Region
Goldfields.

IBRA Region
Gibson Desert, Great Victoria Desert, Nullarbor, Coolgardie, Murchison, Gascoyne, Mallee, Ord Victoria Plains.

FORESTS AND TREE CROPS GROUP

Group Manager: Dr John McGrath

Biometrical Services
Core Function

Team members
M Williams (0.6), A Mellican (1.0); Total (1.6).

Aim
- To raise and maintain standards of research planning and analyses.
- To ensure efficient experimental design.

Summary of progress
- Substantial statistical support to R Bell (Southern Forest Region), C Freegard (Wildlife branch), D Algar, A Wayne (BCG), C Yates, M Buist (BIG), P Ritson, J Mercer (FTCG).
- One paper (hollows/Whitford) published and 4 MS (Armillaria/Robinson, soil C/Whitford, Kingston birds/Abbott, Gray birds/Wardell-Johnson) completed.
- Gave four 2-day statistics training courses (Busselton, Kensington x 2, Albany).
- External consultancies for G Ellis and Oil Mallee Company.
- Gave presentation at FORESTCHECK meeting, July 2002.

Future direction(s)
- Apply for increased funding to enable existing work program to continue.
- The existing work program has continued on annual CF funding of $2 500. In the 2002/03 financial year, in order to balance the budget, an additional $1 130 was raised through external consulting work.

REVEGETATION SYSTEMS UNIT

Mallee sub-program
Core function

Team members
J Bartle (0.4), G Brennan (0.6), W Edgecombe (0.6), P Ryan (0.4); Total (2.0).

Aim
- To conduct reconnaissance, clarify the genetic identity and evaluate the performance of prospective native wheatbelt oil mallee species.
- To select superior oil mallee germplasm from wild populations, test and improve genetic performance and manage seed production of the 6 major mallee species.
- To evaluate establishment and management options for oil mallee cropping systems.
- To determine yield, carbon sequestration and management parameters for combinations of season and frequency of harvest across the range of species and sites.
- To develop large volume, low cost harvest and handling machinery and systems for mallee and other short rotation tree crops.
- To develop new large volume uses for eucalyptus oil.

Summary of progress
- The main selection parameter in first generation genetic improvement of mallee is leaf cineole concentration. This is measured in the lab by gas chromatography of an ethanol extract of a

representative leaf sample. This analysis is contracted out to commercial labs but it is expensive and difficult to quality control. Revegetation Systems Unit (RSU) has been obliged to upgrade its scientific capability in this area. This will enable sharper specification of leaf sampling technique, better quality control in leaf cineole analysis and more elaborate analysis to define minor leaf oil components. Cheaper and more reliable analytical capability will also permit accelerated conversion of progeny trials to seed orchards. This is being complemented by improvement to the mallee breeding database and creation of an analytical framework by which the cost and genetic quality of mallee seed can be efficiently evaluated. This work is underwritten by mallee seed sales revenue that exceeded $60 000 this year.

- RSU established 25 experiment sites designed to test the impact of season and frequency of harvest on mallee productivity. The initial harvest is complete and the first coppice harvest is scheduled for 2004. This work was commissioned by the Oil Mallee Company and will extend over several harvests.
- Development of mallee harvest and handling systems continues at a low level. RSU is prominent in seeking national level collaboration of parties with the need to develop woody crop harvest capability so that this endeavour might be able to attract the necessary level of investment in R&D.

Future direction(s)
The level of R&D investment in mallee will be strongly influenced by the rate of commercial development. There are 2 current major commercial possibilities. The Western Power Corporation $8 million demonstration scale integrated mallee processing facility at Narrogin is nearly complete. If it shows that that mallee processing is feasible rapid expansion in planting is likely to follow. The second commercial opportunity is mallee planting as a carbon sink. The Oil Mallee Company has secured its first such contract. If Australia ratifies the Kyoto Protocols rapid development could ensue. RSU is well positioned to be a major provider of R&D services to this industry.

DCLM Region(s)
Wheatbelt, Midwest, South Coast.

IBRA Region(s)
Avon Wheatbelt, Geraldton Sandplains, Mallee, Esperance Plains.

Search sub-program

Core function

Team members
J Bartle (0.6) D Cooper (1.0), D Huxtable (1.0), J Carslake (1.0), G Brennan (0.4), W Edgecombe (0.4), P Ryan (0.6); Total (5.0).

Aim

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

Summary of progress

- The example of mallee suggests that other native shrubs could be developed as short cycle crops for the wheatbelt. This prospect has been examined in Natural Heritage Trust project 973849 (Developing multiple purpose species for large scale revegetation, commonly called the Search Project). The flora of the south west of WA has been screened for species with the biological potential to become crops, and for potential for products able to compete in large volume markets. This project is approaching completion. The final stage involves the evaluation of product options through manufacture and assessment of performance of sample products like paper, panel board, chemicals and bioenergy.
- Even before the completion of the Search project, the concept has been adopted by the Joint Venture Agroforestry Program (JVAP), and the Co-operative Research Centre (CRC) for Plant Based Management of Dryland Salinity as the theme of future salinity research and new industry development. The RSU is an active collaborator in the national development of R&D based on the search concept. RSU provides the leadership of the woody germplasm subprogram of the CRC and is a major participant

in the joint JVAP/CRC national project called Florasearch.

Future direction(s)
The search project has established a base of field experiments and knowledge of product potential that will be used to identify best bets for commercial development. These best prospects will be subject to more intensive scientific, environmental and commercial evaluation with a view to taking each prospect to the stage of commercial feasibility. RSU will manage a CRC project that will undertake this new industry development work with particular view to opportunities for application in WA.

DCLM Region(s)
Wheatbelt, Midwest, South Coast.

IBRA Region(s)
Avon Wheatbelt, Geraldton Sandplains, Mallee, Esperance Plains.

Adoption sub-program

Core function

Team members
R Moore (1.0), R Hingston (1.0), M Power (1.0), P LeGear (1.0), C Robb (1.0); Total (5.0).

Aim
- To favour the development of native species for sawlog production systems.
- To increase the adoption of tree crops through developing innovative extension programs designed to make tree crops relevant and attractive to every farmer.
- To develop and promote methods of integration of tree crops into farming systems that are convincing to farmers.
- To instigate formation of eucalypt sawlog industries in the medium rainfall zone based as far as possible on native species.
- To improve the standard of farmer management of private native forest in the intermediate and high rainfall zone.
- To improve the standard of training and education in all aspects of tree crops.

Summary of progress
- The considerable body of knowledge relating to the commercial feasibility of an integrated sawlog industry in the 450 to 650 mm rainfall zone has been refined and presented in a form suitable to attract prospective large-scale investors. However, the prospect does not appear to meet the current commercial objectives of investors. Development is therefore continuing to improve sawlog commercial viability through increasing the resource base, improving forestry knowledge of farmers and exploring methods to gain some form of return for the carbon offset or salinity control benefit of tree crops.
- There are some 200 000 ha of private native forest in WA, much of it poorly managed and rapidly degrading. An NHT project is underway to improve the management of this forest. It will provide farmers with a manual of practice to show how native forest can be sustainably managed as well as be utilized for the production of timber. This manual will be compatible with the forthcoming Environmental Protection Act controls on activities in native forest.
- Three more courses under the highly successful Master Tree Growers banner were completed in 2002/03.

Future direction(s)
The adoption sub-program has historically promoted use of recognized commercial timber species. Especially at the wetter end of the agricultural zone these are all exotic species. Given the primary biodiversity protection obligation of DCLM under the amended Act it is no longer a priority to promote such activities, notwithstanding the indirect salinity control and biodiversity protection outcomes that could be generated. The future of the sub-program is under review.

DCLM Region(s)
Wheatbelt, Midwest, South Coast.

IBRA Region(s)
Avon Wheatbelt, Geraldton Sandplains, Mallee, Esperance Plains.

Genetics and molecular biology of tree species

SPP # 98/007

Team members
M Byrne (0.5), B Macdonald (0.5); Total (1.0).

Aim
To provide genetic information for the conservation and utilization of tree species. Current work aims to identify the genetic entities in *Acacia microbotrya* and *A. saligna*; determine the genetic diversity and structuring in *E. marginata* and *E. cladocalyx*; and develop microsatellite markers in *P. pinaster*.

Summary of progress
- *M. uncinata* – Analysis of 2 sites has identified hybridization between some species, including hybridization with the most genetically distinct taxon, *M. atroviridis*, which is non-lignotuberous but likely to be salt tolerant. This indicates that experimental hybridization to combine desired characters is likely to be possible in a breeding program.
- *A. microbotrya* – Genetic analysis with RFLP markers of 25 populations has been completed. Comparative analysis with morphological data is being carried out to identify taxonomic entities and their genetic relationships.
- *A. saligna* – RFLP markers are being assayed in 30 populations from throughout the range of the complex to assess the level of diversity and phylogenetic status of entities in the species complex.
- *E. cladocalyx* – Populations are being assayed for genetic differentiation with microsatellite loci in order to provide a basis for identification of provenance of origin for selected trees to be grafted and included in a breeding program.
- *P. pinaster* – 100 clones of the *P. pinaster* microsatellite library have been sequenced; 30 of these contained microsatellite sequences.
- *E. marginata* – Genetic analysis has shown moderate diversity and little differentiation across the species. The subspecies are not genetically distinct. The populations on the Swan Coastal Plain have been historically isolated from the forest populations.
- Reports and journal papers have been written for *M. uncinata*, *E. angustissima*, *S. spicatum* and *E. occidentalis*.

Future direction(s)
- Reports and journal papers will be written for *A. microborya* and *E. marginata*.
- Laboratory work and analysis on *E. cladocalyx,* and *A. saligna* will be completed.
- Commence work on gene flow between planted tree crop populations and natural remnant populations of eucalypts.

DCLM Region(s)
South Coast, Midwest, Swan, Wheatbelt, South West, Warren.

IBRA Region(s)
Geraldton Sandplains, Esperance Plains, Swan Coastal Plain, Avon Wheatbelt, Yalgoo, Coolgardie, Mallee, Murchison, Jarrah Forest.

ENVIRONMENTAL SERVICES

Early-mid rotation nutrition of *E. globulus* in the south-west of WA
SPP # 93/0128

Team members
I Dumbrell (0.05), K Mungham (0.05), B Copeland (0.05); Total (0.15).

Aim
- Experiment 1. To compare tree growth and nutrient status responses to different rates of pre-plant trace element fertilizer applications. To compare differences between surface application and soil incorporated applications of trace element fertilizer.
- Experiment 2. To compare and contrast survival, growth and nutrient status of *Eucalyptus globulus* seedlings on the south coast to the application of 6 different control-release fertilizers, DAPCuZn tablets or urea.

Summary of progress
- Experiment 1 - No significant differences are apparent between incorporated or non-incorporated treatments in respect to tree height and nutrient status. After 2 yrs, height growth in all treatments is significantly greater than the control treatment but there is no significant difference between rates. Although not significant, the difference in height growth between the 150 kg ha^{-1} trace elements (both inc and non-inc) and the other treatments is increasing and may be significant by the end of the third year. Some response to treatments is evident, but foliar concentrations of zinc and manganese are marginal to adequate in all treatments, including the control. There is a positive linear relationship between applied copper and foliar copper concentrations; However, the concentrations remain below reported adequate concentrations.
- Experiment 2 – No results to date. First annual measurement due in early July 2003.

Future direction(s)
This project is essential to gain further knowledge on the nutrition requirements of *E. globulus*. The response to varying rates of trace elements and modes of application on newly cleared acid peat soil will provide valuable information for prescribing fertilizer requirements in the future.
It is anticipated that this project will run for one more year.

DCLM Region
Warren.

IBRA Region
Warren.

Growth, nutrition and water use of mid-rotation Pines in the medium rainfall zone
SPP # 2000/16

Team members
I Dumbrell (0.2), K Mungham (0.2), BCopeland (0.2); Total (0.6).

Aim
To manipulate existing mid-rotation stands of *P. pinaster and P. radiata* through thinning and fertilization, and to gauge growth responses, water-use and soil water depletion/recharge characteristics both annually and seasonally over a number of years.

Summary of progress
- Soil water contents continue to decline beneath the plantations whereas they remain steady and much higher in the adjacent paddocks. Hectare volume increments continue to increase in all treatments and no tree deaths were apparent.
- So far there have been no drought deaths in the *P. radiata* trial at Wickepin. The reduced growth in the

500 sph and its level of summer water stress would indicate that the risk of maintaining the plantation at this density is not being matched by productivity. Hectare basal area increments have been increasing in the 250 sph treatments over the past 3 dry years and is now outperforming the 500 sph.

Future direction(s)

- Changing climate indicators have led to predictions that this year will be one of average to above-average rainfall. The project began in a year of average rainfall followed by 3 drought years, data gathered in another average or wet year would be invaluable in gaining a greater understanding of the growth and water use characteristics of pines growing in the medium rainfall zone.
- Commence initial write up by July 2003.
- Monthly soil moisture and diameter measurements will continue at 2 sites (Dandaragan and Sth Stirlings) for another year (Aug 2004). Intensive monthly measurements will continue at Wickepin in the *P. radiata* trial for one more year.
- Leaf area data to be collected. Annual measurements in July 2003. Monthly diameter and soil moisture measurements to continue.

DCLM Region(s)
Midwest, Wheatbelt, South Coast.

IBRA Region(s)
Geraldton Sandplains, Avon Wheatbelt, Esperance Plains.

Comparative use of mineral fertilizers and biosolids on the growth and nutrition of pines on the coastal sand plain

SPP # 2000/17

Team members
I Dumbrell (0.15), K Mungham (0.05), B Copeland (0.05); Total (0.25).

Aim
Experiment 1: Mid-rotation *P. pinaster* (estab. 1998)

- To determine the growth response of *P. pinaster* to biosolids.
- To assess the value of biosolids as a fertilizer replacement in plantations.
- To assess the potential for movement of nutrients and heavy metals from the applied biosolids into the soil and groundwater compared to background levels and current fertilizer practice.
- To determine the operational constraints and economic feasibility of biosolids application to plantations on the Swan Coastal Plain.

Experiment 2: Mid-rotation *P. radiata* (estab. 2003)

- To determine the growth response of *P. radiata* to biosolids on the Swan Coastal Plain.
- To assess the value of biosolids as a fertilizer replacement in radiata plantations.
- To monitor soil water movement and variation beneath areas of applied biosolids and standard fertilizer.

Experiment 3: Establishment *P. radiata* (estab. 2003)

- To compare the differences in growth and survival of second rotation *P. radiata* to 4 different site preparation techniques on the Swan Coastal Plain.
- To determine the safe exclusion period from direct land application of biosolids based on pathogen mortality times.

Summary of progress

- Experiment 1. The initial intense monitoring phase of the trial has been completed and the final report written and presented to the Water Corporation. Significant tree volume growth increases above both the control treatment and the standard mineral fertilizer application have shown that biosolids, as a nutrient source and hence a fertilizer replacement in plantations, are a viable option. The longevity of the increased growth in these coastal plantations is yet to be determined and therefore the true value of biosolids is also yet to be determined. The trial will be monitored on an annual basis until tree volume

increments between the treatments are no longer significant. As evidenced by soil water profiles and the lack of contamination of groundwater after 3 yrs beneath plantations on these coastal sands, applying biosolids to these plantations does not pose a threat to groundwater quality.
- Experiments 2 and 3. Sites located.

Future direction(s)
- Continuation of the annual measurements in the *P. pinaster* trial is necessary to determine the growth response longevity to the initial application of biosolids and thus determine the true value of this product.
- *P. radiata* is a faster growing species than pinaster and its nutrient demands are higher. Biosolids have produced significant growth increases in *P. radiata* in the eastern states and overseas and these growth responses are to be tested in stands on the infertile coarse sands of the Swan Coastal Plain. This trial will be linked to a National Biosolids Monitoring Program.
- An opportunity also exists to test the application of biosolids at establishment on 2R *P. radiata* at McLarty. A small trial will go ahead dependent on Health Dept and DEP approval is obtained.

DCLM Region(s)
South West, Swan.

IBRA Region
Swan Coastal Plain.

Early rotation nutrition and silviculture of *Pinus pinaster* on ex-farmland

SPP # 2000/18

Team members
I Dumbrell (0.3), K Mungham (0.5), B Copeland (0.3); Total (1.1).

Aim
To be able to optimise early growth of *P. pinaster* by quantifying critical foliar and soil nutrient concentrations, diagnosis and correction of nutrient deficiencies, and to determine the cause and correction of poor stem form.

Summary of progress
Phosphorus is known to be the critical element required by *P. pinaster* for early growth.
- Foliar P concentrations below 0.07% were found to be deficient for optimal early growth of *P. pinaster*
- Mean plant available P (Olsen bic-P) as low as 0.75 mg kg^{-1} in the surface soil was sufficient for adequate early growth of *P. pinaster*; However, a mean bic-P of 0.04 mg kg^{-1} was clearly inadequate. Therefore, while P is the critical element in the optimal early growth of *P. pinaster,* the amount required is very low.
- No response (or in some cases a negative response) to applications of N or K early in the rotation has been shown for *P. pinaster*. However, nitrogen applied mid-rotation increases wood yield significantly.
- Significant height growth response to the alleviation of manganese deficiency has been shown.
- Poor stem form caused by abnormal late season growth, which is under strong genetic control and triggered by adequate nutrient and water supplies in the soil.

Future direction(s)
This project in early rotation *P. pinaster* grown on ex-farmland is designed to develop growth response curves for N,P, K and NPK interactions, critical foliar and soil concentrations of nutrients for diagnosis of nutrient deficiencies and effective management strategies to deal with stem form disorders.
- Critical concentrations of P in the soil and foliage and height response curves will be refined.
- Need to determine critical concentrations of N and K early in the rotation and determine the optimal age and rate for the application of N in order to maximize yield.
- Develop prescriptions for form pruning in young *P. pinaster* plantations.
- Determine the interaction between stem form and water supply in juvenile plantations.

DCLM Region(s)
Midwest, South Coast.

IBRA Region(s)
Geraldton Sandplains, Esperance Plains.

Mid rotation thinning and fertilization in pines

SPP # 93/0140

Team members
I Dumbrell (0.05), K Mungham (0.1), B Copeland (0.3); Total (0.45).

Aim
To encompass a range of experiments directed towards understanding and optimising mid-rotation nutrition, water-use and growth of pines within the high rainfall zone.
Specifically:

- To determine the response of *P. radiata* and *P. pinaster* to thinning and fertilization separately and in combination and thus describe the interactions involved.
- To determine seasonal patterns of growth and water use of these species.
- To determine if these responses vary between sites in the south-west of the state.
- To determine responses to varying rates of nitrogen and phosphorus separately and in combination for both *P. radiata* and *P. pinaster*.
- To determine effects of nutrient supply and growth rate on wood quality in both *P. radiata* and *P. pinaster*.

Summary of progress

- Determined that silvicultural and edaphic factors do not affect above-ground alometric relationships for *P. radiata*.
- Determined that nitrogen application can significantly increase growth in mid-rotation *P. pinaster.*

Future direction(s)
Investigate whether significant gains from fertilization can be made late in the rotation and whether greater timber volume can be produced by maintaining higher stocking rates late in the rotation.

DCLM Region
South West.

IBRA Region(s)
Swan Coastal Plain, Jarrah Forest.

Essigella californica (a new pest in pines) population monitoring

Core Function - Monitoring Generic Incursions (Plantations)

Team member
J Farr (0.1); Total (0.1).

Aim
To monitor population levels and defoliation impact in line with Australian National considerations co-ordinated through Research Working Group 7 for the Forest Products Commission in WA.

Summary of progress
Report written and submitted.

Future Direction(s)

- No formal project planned.
- Monitor impact of aphid on pine canopies on an *ad hoc* basis through plantation manager vigilance

(Forest Products Commission). Forest Products Commission is aware that this aphid has caused serious defoliation in Victoria.

Effects of reforestation on the quantity and quality of soil organic matter

SPP # not yet approved

Team members
R Harper (0.2), N Robinson (0.25), A Stilwell (0.25), N DeSouza (0.3); Total (1.0).

Aim
To resolve whether there are any differences in the quantity and quality of soil organic matter following reforestation of dryland agricultural areas. Suggestions that revegetation/reafforestation results in a loss of soil carbon have appeared in the literature and are often raised in relation to revegetation projects for carbon sequestration (e.g. 2000 Senate Greenhouse Enquiry). Even with no change in total soil carbon content it has also been speculated that revegetation may result in changed soil organic matter composition – the new organic matter may be more resistant to long term change and thus represent a better long term carbon store than that associated with agriculture.

Summary of progress
- This project has been undertaken with funding from the Griffin Energy ($33 074) and the CRC for Greenhouse Accounting ($5 000). Partners are from the University of WA (Dr D Murphy), Rothamsted Research (Dr A Macdonald) and CSIRO Land & Water (Mr J Skjemstad).
- Soil organic carbon and the light organic matter fraction (LF 1.7) beneath agricultural land were compared with that beneath 7 yr old *Eucalypt* mallee belts in the wheatbelt, 14-20 yr old *Eucalypt* plantations in the Collie Catchment and two 25 yr old multi-species tree plots near Narrogin. Soil organic matter has also been assessed using nuclear magnetic resonance (NMR).
- At all sites, across a range of rainfall zones and soil types, with a range of *Eucalyptus* species of varying age, and different planting systems, the total soil organic carbon and light fraction beneath the trees was not significantly different from that under annual agricultural land. At one site more intensive sampling revealed that total soil organic carbon was significantly greater than under the adjacent pasture.
- This study concluded that any soil carbon lost on establishment of trees is returned to the soil within 7-27 yrs. These results and conclusions are consistent with a recent study that compared soil organic carbon under Tasmanian bluegums on farmland in south-western Western Australia.

Future direction(s)
Completion of 2 papers for refereed journals (by June 2004).

DCLM Region(s)
Midwest, Wheatbelt

IBRA Region(s)
Avon Wheatbelt, Mallee.

Phase farming with trees: field validation and extension

SPP # not yet approved

Team members
R Harper (0.2), N Robinson (0.25), A Stilwell (0.25); Total (0.7).

Aim
To field-test the feasibility of the Phase-Farming with Trees (PFT) concept (Harper *et al*. 2000) in a low rainfall area and demonstrate this to land-holders and other stake-holders. A single cycle of this system (planting – harvest) will be assessed, including quantifying the costs associated with harvest and reversion of land to agriculture. Field experimentation will determine whether the key assumption of the system – *viz* water depletion to 10 m within a 4 yr cycle is possible, and whether it is possible to speed this up by choice of species, stand density or fertilization. If successful the PFT system will result in significant revegetation

and salinity reduction across southern Australia.

Summary of progress

- This project has been undertaken with funding from the Joint Venture Agroforestry Program (Project CAL 6A) and with partners from the University of WA. JVAP funding ($133,000 total) runs until harvest and reversion to agriculture in July 2005.
- Two experimental sites have been established at Wickepin and Corrigin. Trees were planted in July-Aug 2001 (5 species, 5 planting densities), measurement plots established and soil water monitoring equipment installed. Water measurements are being taken both within the treated plots and adjacent cropped paddocks. There has been good (80-95%) survival of the trees across the trial sites despite poor seasonal conditions. Soil water has been depleted to depths of 4.0 m under *E. occidentalis* treatments with the highest planting density (4000 stems/ha) after 20 months.

Future direction(s)

Continued measurement of the plots (growth, water use) until harvest. Collaboration in establishment of Acacia provenance and planting density trials.

DCLM Region

Wheatbelt.

IBRA Region(s)

Avon Wheatbelt, Mallee.

Putting trees in their place

SPP # not yet approved

Team members

R Harper (0.4), N Robinson (0.5), I Dumbrell (0.2), A Stilwell (0.5), R Archibald (0.25); Total (1.85).

Aim

To determine the best placement of trees in dryland farming systems for salinity control.

Summary of progress

This project, which has been undertaken with funding from the NHT Farm Forestry Program (983187) and with partners from the University of WA and CSIRO Land and Water. NHT funding ceased in Sept. 2002. The project has 6 major components:

- Determination of best distribution of trees across farms to achieve salinity control - (a) Existing knowledge reviewed and published. (b) Established 3 long-term field demonstrations/ trial catchments (Wickepin, Wooroloo, and Moora). (c) Combined a soil water model with farm-scale soil/regolith mapping to identify leaky parts of the landscape. This demonstrated large differences in leakage across landscapes – these sites could be preferentially targeted with trees.
- Water use under strips of trees and effect of soil conditions on tree growth (a) Investigated the patterns of tree rooting under mallee belts at 12 locations across the wheatbelt. This information provides confidence that trees can dewater dryland landscapes, with roots penetrating to 10 m deep within 7 yrs of establishment.
- Best planting density within layouts - (a) Ongoing measurements of *Pinus pinaster* thinning and fertilizer trials at Dandaragan, South Stirlings, Harrismith and Wickepin.
- Most suitable species to plant - (a) Multi-species trials established at Wickepin in conjunction with local LCDC Officer. (b) Investigated depth of rooting under different species. Indications that Acacia not as effective as eucalypts. (c) Re-measurement of trees established adjacent to saline seeps at Dryandra, Popanyining and Boundain.
- Effects of soil conditions on tree growth and water use - (a) Root patterns under different species suggest that many soil properties (density, structure) not important for exploitation of water in subsoils. (b) Presented overview of land evaluation systems for farm forestry. (c) Evaluated use of gamma radiometrics for land evaluation for tree placement.
- Extension of information - 13 papers presented at local and interstate meetings with 23 additional oral

presentations to an array of audiences.

Future direction(s)
Continued measurement of instrumented catchments. We have obtained one-year's additional funding from Joint Venture Agroforestry Program in collaboration with CSIRO Land & Water to continue measurements of the catchment installations.

DCLM Region
Wheatbelt.

IBRA Region(s)
Avon Wheatbelt, Mallee.

Evaluation of reforestation potential of Western Australian farmland

SPP # 93/158

Team member
R Harper (0.20); Total (0.20).

Aim
To use existing soil and climatic data-sets to predict the reforestation potential of Western Australian farmland.

Summary of progress
- This study comprises 2 discrete projects, undertaken for the Forest Products Commission and Griffin Energy. The FPC project involved an assessment of regional scale (1 : 2 000 000) soil mapping to determine the suitability for an array of farm forestry species. The Griffin project utilized soil data at the catchment scale (1 : 50 000 – 1 : 100 000) and determined the distribution of limiting soil factors for revegetation. A climatic overlay was used to produce a productivity surface and the location and gross wood yields were estimated.
- Both components were undertaken in collaboration with R Tomlinson of the DCLM Information Management Branch.

Future direction(s)
The analytical techniques developed in this project are suitable for use in any catchments where revegetation is being contemplated.

DCLM Region(s)
Midwest, Wheatbelt, South West, South Coast, Warren, Swan.

IBRA Region(s)
Avon Wheatbelt, Mallee, Jarrah Forest, Warren, Esperance Plains, Swan Coastal Plain.

Productivity and drought risk to *Eucalyptus globulus* in the Mediterranean climate of south-western Australia

SPP # 99/08

Team members
J Kinal (0.5), D Mickle (0.25), R Hill (0.25), J McGrath (0.1); Total (1.1).

Aim
- To establish quantitative relationships amongst climate, growth, leaf area index, water use, soil depth and the development of water stress in blue gum plantations across south-western Australia.
- To quantify the leaf area index and productivity that are sustainable on a given site and the risks associated with deviations from these values.
- To recommend silvicultural options for achieving a sustainable leaf area index and wood production.

- To modify the plantation growth model CABALA to include a dynamic water balance and apply this model to an analysis of risk.
- To develop desk-top ready software to enable managers to predict drought risk–productivity relationships.

Summary of progress
- Measurements of soil water content, tree water status, and leaf area index were made from spring through autumn, and of tree growth in spring, at all sites.
- All industry partners were visited to demonstrate the capability of the tree-growth model CABALA and to simulate volume growth on real operational plantations.
- Work has begun on a more user-friendly interface for CABALA plantation growth model.

Papers presented at conferences
- Battaglia, M., White, D., Mummery, D. and McGrath, J. (2002) Modelling drought risk of *Eucalyptus globulus* plantations in a Mediterranean climate. Paper presented to conference 'Reality, models and parameter estimation – the forestry scenario', 2-5 June 2002, Sessimbra, Portugal.
- White, D., Battaglia, M., McGrath, J. Mummery, D. and Kinal, J. (2002) Managing the trade off between growth and drought risk in bluegum plantations - a physiological basis. In Proceedings EucProd 2002: International Conference on Eucalypt Productivity, Hobart, Tasmania, 10-15 Nov, 2002
- White, D., Battaglia, M., McGrath, J. Mummery, D. and Kinal, J. (2002) Managing the trade off between growth and drought risk for sustainable production in bluegum plantations. In Proceedings Australian Forest Growers Biennial Conference, Albany, WA, 14-16 Oct 2002.

Future direction(s)
- Workshop with plantation industry partners July 2003 for feedback on model development.
- Continuing measurement program concentrated in the summer drought period, late spring to autumn.
- Further development of the model CABALA.
- Development of look-up tables for assessment of site yield potential and risk.
- Project due for completion Aug 2004.

DCLM Region(s)
South West, Wheatbelt, South Coast.

IBRA Region(s)
Jarrah Forest, Warren, Esperance Plains.

Investigate genetic variation in a range of endemic and exotic plantation species

SPP # 93/0126

Team member
R Mazanec (1.0); Total (1.0).

Aim
- To provide best available information on seed source for a range of species.
- To select elite trees for clonal seed orchards.
- To design seed orchard.

Summary of progress
Oil Mallee trials:
- In 2002, analysis of data from a large Oleosae seed orchard indicated the existence of very high oil yields (over 8% cineole). Such unprecedented oil yields combined with a recent change in laboratories conducting the gas chromatography precipitated an exhaustive investigation into the reasons for the high readings and the reliability of the data.
- Data quality underpins accuracy of selection, subsequent orchard thinning, seed quality and profitability of oil production. Data quality may potentially be affected by a wide number of factors including sampling laboratory techniques, sampling technique in the field, location of leaf samples on the tree and

potentially time of year when leaf sample is collected.

- Investigations this year have focused on the laboratory aspect of the sampling process - Gas Chromatography (GC).
- Outcomes include improved technique in GC technique.
- Greater consistency between tests on standard solutions.
- More reliable standard curves for calculation of cineole percentages.
- Better understanding of the achievable accuracy and consequences for selection.
- Culling plan for the seed orchard.

Hybrid trials:

- A series of 10 eucalypt hybrid trials was analysed for the FPC. The objective of these trials was to compare the performance of pure species and hybrids on a range of sites. Trials were established in locations as diverse as Pemberton, Wellington catchment, Boyup Brook, Grimwade, Darkan, Albany, Gingin, Mt Barker and Kojonup.
- Traits assessed included height, diameter, stem form, branching, malformation and survival. Trials were assessed at varying ages, with 7 trials assessed at 3 or 4 different ages ranging from 5 - 80 mths. Species identity was coded so treatment identity was not possible for DCLM.
- Results suggest variable performance and survival of both pure species and hybrids with site.
- Complete set of analysis outputs supplied to FPC.

Trial Design:

- Two sandalwood (*Santalum spicatum*) and 2 *Acacia microbotrya* trials were designed for the FPC.
- Two *E. viminalis* trials were established in 1990 near Bridgetown and in the Wellington catchment. The trials included 17 provenances of *E. viminalis* ssp *viminalis* and ssp *cygnetensis*, 2 provenances of *E. nobilis* and one provenance of *E. pryorana* (both species closely related to *E. viminalis*).
    - Manuscript almost completed. As the largest proportion of the trial consisted of *E. viminalis* subspecies *viminalis*, additional analysis on that data subset was conducted to enable calculation of genetic parameters for pure *E. viminalis.*
    - Heritabiliy, phenotypic and genetic correlations for both sites on height, diameter, volume were moderate indicating significant gains could be made from selection and breeding. Heritability for stem straightness and branching were of similar magnitude but genetic correlations with growth traits were negative. This suggests that improvement in form will come at the cost of volume improvement.
    - Type B genetic correlations between sites for pure *E. viminalis* provenances were near unity for height, diameter and individual tree volume suggesting no genotype by environment interaction for these traits. By contrast, correlations were relatively low for branching r_{gB} = 0.5 and for straightness r_{gB} = 0.2 indicating significant genotype x environment interaction for these 2 traits.

Publications

- Mazanec, R.A. Mason, M.L. and Vellios C.V. (2003) Performance of spotted gum provenances for timber production on former bauxite mines in Western Australia. *Australian Forestry* In press.
- Meddings, R.A., McComb, J.A. Calver, M.C., Thomas S.R. and Mazanec, R.A. (2003) *Eucalyptus camaldulensis* x *globulus* hybrids. *Australian Journal of Botany*. In Press.
- Bolitho, M. Soong, P., Atkins, K., Dawson, R., Mazanec, R. Richardson, B. (2002). The departments internal web services- opportunities and challenges. LODP internal report.

Future direction(s)

- Retesting of some batches of oil samples (mallee) identified as suspect.
- Investigate effect of sampling time in the field i.e. seasonal effects on oil concentrations.
- Detailed investigation of effect of leaf sampling locations on the tree, size of sample and sampling technique on estimates of leaf cineole content
- Northern jarrah trials established in 1988 near Jarrahdale and Dwellingup require measurement. These trials include 21 provenances from the Northern jarrah forest and 4 provenances from the southern jarrah forest. Selections made from these trials may then be screened for dieback resistance.

DCLM Region(s)

Wheatbelt, Midwest, South West.

IBRA Region
Mallee.

Maritime pine site quality and yield studies

No SPP #

Team members
P Ritson (0.25), B Brand (0.25); Total (0.5).

Aim
- To develop an operational system for site quality assessment of *P. pinaster* plantations on farmland in WA.
- To develop a yield model to predict stemwood yield from site index (SI) and management factors (planting layout, silviculture, genetics).

Summary of progress
- Operational system for site quality assessment for *P. pinaster* on farmland developed and delivered to FPC (Technical Report, Operational Guidelines and Excel spreadsheet).
- Yield model developed and incorporated into *FarmWood* (predicts stemwood volume and carbon sequestration). The yield model predicts future stemwood volume from SI and management factors and/or measurement of current stemwood volume. Model delivered to FPC (Tech. Report) but refinement of the model is an ongoing process.

Future direction(s)
- Verification of yield model with late- and early-rotation measurements and re-calibrate if necessary. Early growth measurements on new *P. pinaster* plantations will be utilized as they become available. Currently only stem growth measurements obtained by stem analysis of plantations established in the 1970s and 1980s have been used to calibrate the model but there are indications that early growth in new plantations has been advanced by more efficient establishment silviculture.
- Some work on refining thinning simulation in the model based on measurements in past and on-going thinning experiments is warranted.
- Publish the site quality and yield prediction studies in refereed journals.
- Work with FPC operations staff on application of the results of these studies.

DCLM Region(s)
Midwest, Swan, Wheatbelt, South West, South Coast.

IBRA Region(s)
Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Avon Wheatbelt, Esperance Plains.

Biomass and carbon studies

No SPP #

Team members
P Ritson (0.25), B Brand (0.25); Total (0.5).

Aim
- To develop equations to estimate biomass and carbon content of individual trees in *P. pinaster* and *E. globulus* from easily measured variables such as DBH.
- To develop model to forecast biomass accumulation and carbon sequestration of farm forestry species.
- To provide technical support to BP tree planting project (trial of greenhouse gas emission offsets from carbon sequestration in afforestation).
- To undertake scoping study on potential of eucalypt sawlog species to sequester carbon and extend of resource available for study through destructive sampling.

Summary of progress

- Biomass and carbon mass prediction equations have been developed for *P. pinaster* and *E. globulus*.
- *FarmWood* model developed and supplied to FPC. The model is intended as an aid to forecasting and managing timber production and carbon sequestration in afforestation projects. Most work and most application so far has been for *P. pinaster* & *E. globulus*. Some calibration has been done for eucalypt sawlog species and *P. radiata*.
- Change in soil carbon included in *FarmWood* based on review of local measurements and scientific literature (Tech. Report to FPC).
- Uncertainty analysis methods using Monte Carlo technique developed for biomass and carbon inventory of *P. pinaster* plantations developed (Tech. Report to FPC.
- Scoping study on carbon sequestration in eucalypt sawlogs commenced with report planned by end of June.

Future direction(s)

- Publish *FarmWood.*
- Consider undertaking field studies on carbon sequestration in eucalypt sawlog species.

DCLM Region(s)
Midwest, Wheatbelt, South Coast.

IBRA Region(s)
Geraldton Sandplains, Avon Wheatbelt, Esperance Plains.

CRC Greenhouse Accounting studies

No SPP #

Team members
P Ritson (0.5), S Sochacki (1.0), B Brand (0.5); Total (2.0).
Note: S Sochacki salary and operating budget funded by the CRC.

Aim

- To develop the most efficient root sampling method.
- To quantify the effect of environment and management factors on root : shoot partitioning.
- To develop capacity to predict root and slash decay rates post-harvest.

Summary of progress

- Intensive sampling of root systems to 6 m depth of 2 *E. globulus* trees completed. This will allow simulation and comparison of alternative root sampling strategies.
- Sampling of root and above-ground biomass in a *Pinus radiata* mid-rotation nitrogen (N) fertilizer experiment completed. Initial analyses indicate that while there was a growth response to increasing nitrogen there was no significant change in root : shoot partitioning.
- Reviewed methods for study of root and slash decay rates and submitted proposal for such studies to CRC and Australian Greenhouse Office.

Future direction(s)

- Complete and publish studies on root sampling methods.
- Complete and publish studies on root : shoot partitioning.
- Undertake studies on root decay rates and factors affecting root decay rates in collaboration with other CRC partners and the Australian Greenhouse Office.

DCLM Region(s)
Midwest, Wheatbelt, South West, South Coast.

IBRA Region(s)
Geraldton Sandplains, Avon Wheatbelt, Esperance Plains.

ECOLOGICALLY SUSTAINABLE FOREST MANAGEMENT

Quantitative population monitoring of gumleaf skeletonizer (GLS, *Uraba lugens*)
SPP # 93/0103

Team member
J Farr (0.05); Total (0.05).

Aim
To understand the biology of GLS in WA and monitor population levels of the outbreaking insect.

Summary of Progress
- Fieldwork completed.
- A paper on the biology of GLS was published: Farr, JD. (2002). Biology of the Gumleaf Skeletonizer (*Uraba lugens* Walker: Lepidoptera, Noctuidae) in the southern Jarrah forest of Western Australia. Aust. J. Entomology 41: 60-69.
- Data on population levels (using a cherry picker) are yet to be incorporated into a publication.

Future direction(s)
- Assess potential for data to be incorporated into a joint paper including jarrah leafminer population trends.
- Should the above be infeasible then prepare an internal report to enable finalization of the project.
- This achievement has been given low priority.

DCLM Region
Warren.

IBRA Region(s)
Jarrah Forest, Warren.

Distribution of gumleaf skeletonizer (GLS) in the central and southern forests of WA
SPP # 93/0104

Team member
J Farr (0.2); Total (0.2).

Aim
To map the distribution of GLS in relation to outbreak periods and investigate possible cause of outbreak.

Summary of progress
- Fieldwork completed and data analysed.
- Manuscript completed. Title: Spatial analysis of *Uraba lugens* Walker (Lepidoptera: Noctuidae) outbreak in the southwest of Western Australia: Does logging, vegetation type or fire influence outbreaks?
- Internal peer review of manuscript completed.
- Manuscript submitted to Australian Forestry (Jan 2003), awaiting referees' reports.

Future direction(s)
Finalize manuscript for publication in 2003, taking into account referee and editorial suggestions.

DCLM Region(s)
Warren, South West.

IBRA Region(s)
Jarrah Forest, Warren.

Biology of the new psyllid *Cardiaspina jerramungae* in the lower great southern of WA on flat-topped yate

SPP # Nil: A combination of several old RPPs.

Team member
J Farr (0.2); Total (0.2).

Aim
To understand the biology and population dynamics of this new outbreaking psyllid.

Summary of progress
- Fieldwork completed.
- Data validated and analysed. Life tables for 1989-1993, incorporating 14 generations, completed.
- Manuscript near completion.

Future direction(s)
- Complete manuscript.
- Submit manuscript to internal peer review.
- Submit manuscript to journal (Australian Journal of Entomology).

DCLM Region(s)
Wheatbelt, Warren, South Coast.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Mallee, Jarrah Forest.

Pest incursion of *Cardiaspina fiscella* in WA

No SPP #

Team member
J Farr (0.05); Total (0.05).

Aim
To continue vigilance for introduction of potential new forest (tree) pests to WA.

Summary of progress
- No formal work is being done.
- Current distribution of *Cardiaspina fiscella* now confirmed as ranging from Perth to Albany.

Future Direction(s)
At a Forest Health Advisory Committee (FHAC) meeting in April 2003 it was decided to produce an information leaflet on this insect.

DCLM Region(s)
Swan, Wheatbelt, Warren, South Coast, South West.

IBRA Region(s)
Avon Wheatbelt, Esperance Plains, Mallee, Jarrah Forest, Swan Coastal Plain.

Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the Jarrah forest

SPP # 2000/03

Team members
J Kinal (0.5), D Mickle (0.25), R Hill (0.25); Total (1.0).

Aim
To investigate the hydrologic impacts of timber harvesting and the associated silvicultural treatments in the intermediate rainfall zone (IRZ, 900 – 1100 mm/yr) of the jarrah forest. This project also addresses part of Ministerial Condition 12-3 attached to Forest Management Plan 1994-2003, which states that DCLM shall monitor and report on the status and effectiveness of silvicultural measures in the IRZ to protect water quality.

Summary of progress
- Post-silvicultural treatment (pre-silvicultural burn) changes in overstorey density were assessed from measurements of crown cover, crown density index, basal area, and stocking in winter-spring 2002.
- A post-silvicultural treatment burn was conducted in late spring 2002.
- The intensity and distribution of the post-silvicultural treatment burn was assessed by a survey of crown scorch and fuel consumption.
- A hydrological model, WEC-C, has been fitted to the pre-treatment data (years 1991 – 2000) for 6C catchment.
- Results from the second year following treatment show that the standard treatment continued to have no apparent effect on groundwater recharge. In contrast, groundwater levels rose by about 0.1 m on the hillslopes in response to the intensive treatment. The magnitude of these changes is much smaller than the changes in groundwater level in response to the timber harvesting and associated silvicultural practices of the early 1980s where average groundwater levels rose more than 1.7 m in the valleys and hillslopes in the first 2 yrs following treatment.

Future direction(s)
- Monitoring of groundwater levels, stream flow, stream salinity, stream turbidity and rainfall should continue for a further 3 yrs.
- Apply WEC-C hydrological model to post-treatment data to assess its suitability for predicting longer-term hydrological responses to the treatments.
- Use WEC-C to simulate hydrological responses to alternative timber harvesting and silvicultural treatments, and to different climate patterns.

DCLM Region
Swan.

IBRA Region
Jarrah Forest.

Assessment of the emissions of dioxins from bushfire activity in Australia
Consultancy to Environment Australia's National Dioxins Program

Team members
L McCaw (Team Leader) (0.1), R Smith (0.1), J Neal (0.1); Total (0.3).

Aim
To sample particle mass and gaseous emissions from prescribed and wildfires in forests, plantations and heathlands in south-west Western Australia. Data will be used to quantify the contribution that bushfires make to national dioxin emission levels.

Summary of progress
- Environment Australia has initiated a National Dioxins Program to determine levels of dioxins in the general environment, and sources of dioxin emissions from bushfires and motor vehicles. Sampling of emissions from bushfires is being co-ordinated by CSIRO Division of Atmospheric Research, with field measurements undertaken by participating organizations in several states. A vehicle-mounted sampling unit has been developed and tested by CSIRO, with a unit delivered to the Department in Nov 2002.
- Samples have been collected from 3 low intensity prescribed fires in south-west forests over the 2002/03 season.

Future direction(s)
Additional sampling from fires in pine plantation and shrubland are scheduled during winter and spring 2003.

DCLM Region(s)
Warren Region, South West, Swan, South Coast.

IBRA Region(s)
Jarrah Forest, Warren.

Increasing productivity of Karri regrowth stands by thinning and fertilizing

SPP # 93/106

Team members
L McCaw (Team Leader) (0.05), R Smith (0.05); Total (0.1).

Aim
To provide information about the effects on tree and stand growth of a range of silvicultural treatments that may be applied to even-aged stands of Karri regrowth. Treatments in experimental designs include:

- thinning from below,
- fertilizing with macronutrients and trace elements,
- coppice control.

Summary of progress
No measurements were undertaken during 2002/03.

Future direction(s)
All 4 experiments have now been monitored for at least 10 yrs post-treatment, and it would be expected that responses to thinning are now in a declining phase. The need for ongoing monitoring should be reviewed in the context of strategic directions set in the new Forest Management Plan, in particular the allowable level of harvest from regrowth stands of Karri.

DCLM Region
Warren.

IBRA Region
Warren.

Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest

SPP # 97/03

Team members
L McCaw (Team Leader) (0.5), R Smith (0.2), J Neal, (0.2); Total (0.9).

Aim

- To develop a national fire behaviour prediction system for dry eucalypt forests.
- To quantify changes in fire behaviour as fuels develop with age.
- To develop new algorithms describing the relationship between fire spread, wind speed, and fuel characteristics.
- To characterize wind speed profiles in forests with different over-storey and understorey structures.

Summary of progress
Fire spread and fuel data have been analysed to identify the key variables influencing fire spread. Conclusions that can be drawn at this stage include that:

- It is possible to identify fuel variables that provide better explanatory power for rate of spread than does surface litter fuel load.

- Fuel variables can account for site-related differences in vegetation structure and density, making models transportable across a range of site conditions.
- Visually-based hazard rating systems have potential to replace more labour-intensive methods of fuel assessment for application in rate of spread prediction.

The project has also demonstrated that fire size has a significant effect on the potential rate of spread and that existing fire behaviour models tend to consistently under-estimate rate of spread for fires with a head wider than 100 m.

Future direction(s)
The project is due for completion by the end of June 2003 at which stage a major report will be delivered to the Australasian Fire Authorities Council, the co-ordinating body representing agencies that supported the project. Ongoing work will be required to prepare manuscripts for publication in scientific journals, and to develop material for training and technical transfer purposes. Further experimental fires to validate the results of Project Vesta in a range of south-eastern Australian forest types will be undertaken through the Bushfire Cooperative Research Centre, which commences operation in July 2003. Departmental staff are likely to play an advisory role in the establishment of these experiments and the interpretation of results.

DCLM Region(s)
South West, Swan, Warren.

IBRA Region(s)
Jarrah Forest, Warren.

Espacement effects on the development and form of regrowth Karri stands
SPP # 93/107

Team members
L McCaw (0.01), R Smith (0.01); Total (0.02).

Aim
To investigate the effects of initial stocking and espacement on stand growth, individual tree growth and form of Karri planted following clearfelling harvest operations.

Summary of progress
No measurements were undertaken during 2002/03, and none are due until 2005.

Future direction(s)
This project should be maintained as an important benchmark study with re-measurement scheduled on a 5 yrly cycle. There is an opportunity to use this study as the basis for investigations of the impact of branching habit on the incidence of wood defect in stems.

DCLM Region
Warren.

IBRA Region
Warren.

Armillaria spread in Karri
SPP # 98/0006

Team members
R Robinson (0.13), R Smith (0.05); Total (0.18).

Aim
To investigate control methods of Armillaria root disease in Karri regrowth forest and investigate the effects of management on Armillaria root disease in Karri regrowth forest and to investigate how Armillaria root

disease affects Karri tree growth.

Summary of progress
- Liaison with FPC on operational methods of control.
- Scientific paper published in Journal (Robinson, R.M. 2003. Short-term impact of thinning and fertilizer application on Armillaria root disease in regrowth Karri (*Eucalyptus diversicolor* F. Muell.) in Western Australia. Forest Ecology and Management 176: 417-426).
- Scientific paper In press (Robinson, R.M., Williams, M. and Smith, R.H. Incidence of Armillaria root disease in Karri regrowth forest is underestimated by surveys of above ground symptoms. Australian Forestry).
- Scientific paper in prep. (The effect of *Armillaria luteobubalina* on the growth and yield of Karri regrowth trees).

Future direction(s)
Involvement with Sustainable Forest Management Division and FPC on developing and monitoring operational control methods for ARD during first thinning operations.

DCLM Region
Warren.

IBRA Region
Warren.

The effect of wildfire on fungi
SPP # 98/0015

Team members
R Robinson (0.33); R Smith (0.1), K Pearce (0.17); Total (0.51).

Aim
To investigate the effects of wildfire on fungi in Karri forest and to monitor the succession of fungi on burnt sites in Karri forest.

Summary of progress
- The results show that a distinct and recognizable fungal flora fruits on recently burnt sites. A number of fungi appear to be stimulated to fruit by fire or take advantage of the post-fire conditions. As time progresses those fungi that are adapted to post-fire conditions are replaced by species more commonly found in unburnt forest.
- Field work completed (5 yrs of results).
- 3 Annual reports completed.
- Book chapter published (Robinson, R.M. and Bougher, N.L. The response of macro-fungi to fire in jarrah (*Eucalyptus marginata*) and Karri (*Eucalyptus diversicolor*) forests. *In* Abbott, I. and Burrows, N. (Eds). Fire in Ecosystems of South-West Western Australian: Impacts and Management, pp. 269-289).
- Data analysis in progress.

Future direction(s)
- Field work to be completed after 5 yrs.
- The next monitoring will be undertaken in 2008 (coinciding with 10 yrs post fire). Laboratory work will continue to catalogue and identify voucher specimens collected throughout the project.
- Results for the first 5 yrs to be published in a scientific paper.
- Collaborate with colleagues from outside agencies with identification of voucher specimens.

DCLM Region
Warren.

IBRA Region
Warren.

FORESTCHECK - Invertebrate biodiversity study

Core function

Team members
J Farr (0.3), A Wills (0.2), T Burbidge (0.35); Total (0.85).

Aim
To monitor invertebrate biodiversity in the WA jarrah forest in relation to silvicultural practices.

Summary of progress
- The second year's (2002) spring and autumn sampling is complete and has been databased.
- Samples were sorted to morphospecies and the reference collection extended from that already established in 2001.
- Over 800 morphospecies have now been collected.

Future direction(s)
The 2003 spring/autumn sampling will commence in Oct/Nov 2003.

DCLM Region(s)
Swan, Warren, South West.

IBRA Region(s)
Jarrah Forest, Warren.

FORESTCHECK – Monitoring biodiversity in south-west forests

Core function

Team members
This project involves a number of staff from the Ecologically Sustainable Forest Management team, with assistance from staff at the WA Herbarium.

Aim
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.

Summary of progress
A specific progress report on this project is available on the Science Division page of the DCLM Web at: http://www.calm.wa.gov.au/science/science.html.

Future direction(s)
Monitoring grids are to be established in the Northern jarrah forest in 2004/04 financial year.

DCLM Region(s)
Warren, South West, Swan.

IBRA Region(s)
Jarrah Forest, Warren.

FORESTCHECK - Fungi, coarse woody debris, and litter assessment

Core function

Team members
R Robinson (0.22), R Smith (0.12); Total (0.34).

Aim
To monitor the effects of forest management (logging) on fungi, coarse woody debris and litter in jarrah forest.

Summary of progress
- Field work for 2001-2 completed and report presented and published in Annual Report.
- Field work for 2002-3 in progress.

Future direction(s)
- Complete field work for 2002-3 monitoring.
- Prepare and present 2003 Annual report.
- Install grids and transects for 2003-4 monitoring.

DCLM Region
South West.

IBRA Region
Jarrah Forest.

FORESTCHECK – Soil assessment

Core function

Team members
K Whitford (0.3), J Neal (0.02), R Smith (0.02); Total (0.34).

Aim
- To record the extent of soil disturbance on FORESTCHECK monitoring sites where machine disturbance (snig tracks) can be readily identified.
- To monitor the intensity of changes to soil physical properties induced by logging.
- To monitor any change in these soil physical properties over time.

Summary of progress
- A second replicate of FORESTCHECK monitoring sites was established this year.
- We successfully mapped the snig tracks and landings on 5 new sites. This mapping provides a permanent record of the location of major soil disturbance on these sites, and enables determination of the proportional area of the fallers block disturbed by logging machinery, i.e. a measure of the extent of soil disturbance on the fallers blocks.
- We collected 210 bulk density measurements on 2 sites. These measurements provide information on the intensity of soil disturbance on these sites, and the size of the changes in bulk density induced by logging, relative to an undisturbed site.
- Knowledge gained from the first and second years of FORESTCHECK soil monitoring has been used to provide advice for the preparation of the current Forest Management Plan, and in preparation of advice to the Conservation Commission regarding the setting of soil moisture and soil disturbance limits for logging activities.

Future direction(s)
- FORESTCHECK is an ongoing monitoring program that records the impacts of logging operations at a range of sites throughout the Jarrah forest. The value of this data accrues as similar measurements are repeated on additional sites. No changes in the current measurements are proposed. Additional sites will be measured next year.
- The first and second years of FORESTCHECK provide sufficient data to produce a report on the extent and intensity of soil disturbance on logged sites in the Jarrah forest. Compiling and reporting this information would greatly increase the documented knowledge of soil disturbance in these forests. This would be an

expansion of the information found in the individual annual FORESTCHECK *Progress Reports*. I propose to compile this report after the 2003/04 FORESTCHECK field work is complete and a larger data set is available.

DCLM Region(s)
South West, Warren.

IBRA Region
Jarrah Forest.

Selection, screening and field testing of Jarrah resistant to *Phytophthora cinnamomi*

SPP # 93/0112

Team member
M Stukely (0.15); Total (0.15).

Aim

- To collect and screen a wide range of Jarrah provenances (half-sib families) for resistance to *Phytophthora cinnamomi* (Pc).
- To select outstanding individuals from Pc-resistant families for propagation, field validation testing, and inclusion in seed orchards.
- To test clonal lines of Pc-resistant Jarrah in field inoculation trials to validate their selection for inclusion in seed orchards.
- To establish a DCLM/FPC seed orchard for production of Pc-resistant Jarrah (NHT Project 003072 – 'Producing Dieback Resistant Jarrah for land and forest rehabilitation').

Summary of Progress
Background:

- All elite Dieback Resistant Jarrah (DRJ) selections from the provenance screening trials to date have been propagated by tissue culture at Alcoa's Marrinup laboratory.

Field Validation trials:

- The superiority (in terms of both survival and growth rate) of DRJ clones in earlier field trials has now been maintained for up to 15 yrs. Survival and growth of the DRJ has generally been good in 2 major field validation trials of DRJ clones that were established in winter 1999 on dieback-infested sites in the jarrah forest. (These provide a harsher environment than the earlier validation trials planted on former bauxite pits). Some drought deaths were recorded at both sites. There were minimal losses in 2002-03.

Clonal DRJ Seed Orchard, DCLM/FPC (NHT Project 003072):

- In July 2002, survival of DRJ clones planted in 2001 in Stage 1 of the major production seed orchard at the FPC Manjimup Plant Propagation Centre was 80%.
- Stage 2 was planted in July 2002, using additional numbers of existing lines, and some new lines; the total number of unrelated DRJ lines planted is now 27.
- DRJ clones are now in production for Stage 3 (infill planting) in July 2003. Further production of clones will be required to reach the goal of 35 lines, and for infilling after losses (2004).
- First seed is expected to be produced within about 3 yrs.

Seedling inoculation trials (NHT Project 003072):

- A series of glasshouse inoculation trials was carried out in summer/autumn 2002-03, using seedlings derived from surviving resistant lines in early field inoculation trials. These trials will give the first indication of the likely performance of the DRJ seed orchard progeny. Final assessments are now due.

Future direction(s)

- Carry out final assessments and analyse data for 2002-03 inoculation trials on seedling progeny of

survivors in early field inoculation trials (NHT Project 003072).

- Infill planting of DRJ Seed Orchard at Manjimup PPC in July 2003 (following completion of Stage 2 in 2002 as part of NHT Project 003072), and 2004.
- Future research relating to the DRJ Seed Orchard will necessarily include initial testing of its progeny for Pc resistance, possibly more refined testing of existing lines (arising from recent work at Murdoch University), elimination of inferior lines based upon performance data, and possibly the focused selection and cloning of additional resistant lines to maintain the required level of genetic diversity in the orchard in the long term. Maintenance of the seed orchard will be done by staff of the FPC Seed Centre, after establishment.
- Once seed production starts in the seed orchard (expected within 5 yrs after planting), DRJ seedlings will be grown in the nursery and made available to DCLM managers, community groups and land holders for use in rehabilitation plantings of degraded forest and cleared sites. Further work on field establishment of jarrah is needed (see SPP # 94/0006).
- The DRJ growth rates regularly seen in our field trials indicate that jarrah has potential for use as a plantation species in suitable environments, and also in reafforestation programs linked to the Salinity Action Plan on suitable sites in the landscape (e.g. mid to upper slope water recharge areas). Jarrah has been included in a small number of trials here, and should be assessed further.
- Linkage with jarrah genetics trials of R Mazanec.

DCLM Region(s)
Warren, South West, Swan, Wheatbelt.

IBRA Region(s)
Jarrah Forest, Swan Coastal Plain, Avon Wheatbelt, Warren.

Dieback-resistant Jarrah establishment in operational forest rehabilitation sites

SPP # 94/0006

Team member
M Stukely (0.3); Total (0.3).

Aim
To re-establish jarrah, initially using clonal, dieback-resistant plants, in operational Dieback Forest Rehabilitation (DFR/FIRS) sites.

Summary of progress

Background

- About 20 plots (in addition to the Validation Trials, SPP # 93/0112) were established between 1994 and 1999, using clonal DRJ in forest rehabilitation sites in Jarrahdale, Dwellingup, Mornington and Busselton Districts.
- Survival has been variable, from below 20% on very harsh sites to c. 80 % on better sites.
- Due to the high expense of producing DRJ clones, and difficulties with re-establishing jarrah in forest sites, the clones will now be used to establish seed orchards, rather than directly planting them into operational forest rehabilitation sites.

2002-03

- Further field assessment work was deferred in 2002-03, due to the NHT project taking priority.
- Alcoa have provided funds for establishing trials in 2003 to test treatments for establishing seedling jarrah on DFR sites, and planning is now in progress.

Future direction(s)
With the DRJ Seed Orchard now established, this SPP will now incorporate trials of site preparation treatments for jarrah seedling establishment in forest sites. This will also develop on the earlier work started by G Stoneman (SPP # 93/0094).

DCLM Region(s)
South West, Swan.

IBRA Region
Jarrah Forest.

Vegetative propagation by grafting of dieback-resistant Jarrah for seed orchard establishment

SPP # 95/0014

Team members
M Stukely (0.02); L Barbour (FPC); Total DCLM (0.02).

Aim
To assess the feasibility of grafting to capture and vegetatively multiply Dieback-Resistant Jarrah (DRJ) selections for establishment in seed orchards (NHT Project 003072).

Summary of progress
- Grafting trials (in the glasshouse) are being carried out by FPC staff with plant material supplied by DCLM.
- Low success rates were achieved in the first trials (2002), and these were compounded by problems with maintaining adequate watering in summer.
- Root-stocks have been grown at Kensington for the second set of trials (2003) which are being carried out at Wanneroo propagation centre, with larger numbers of plants. Results are awaited.

Future direction(s)
If grafting can be used successfully with jarrah, this method can be used to propagate DRJ lines that are difficult to tissue-culture, which will permit their inclusion in seed orchards.

DCLM Region
Swan.

IBRA Region
Jarrah Forest, Swan Coastal Plain, Avon Wheatbelt, Warren.

Mundulla Yellows disease in WA

SPP # not yet approved

Team member
M Stukely (0.13): Total (0.13).

Aim
To monitor Mundulla Yellows (MY) disease occurrence and spread in Western Australia.

Summary of progress
- Monitoring of MY in WA by DCLM has continued, in collaboration with Dr D Hanold and Prof J Randles (University of Adelaide). Dr Hanold visited WA in Sept 2002 to establish transects for monitoring MY spread, and to survey for symptoms and collect samples from a wider area (Geraldton to Esperance Plains).
- Due to ongoing problems with funding, Hanold and Randles have made only limited progress in researching the cause of MY in the last 12 mths. Samples currently cannot be tested. They now have in press a report of MY symptoms in eucalypts in Spain.
- MY symptoms have been recorded by me in WA in remnant *Eucalyptus marginata*, *E. todtiana*, *E. camaldulensis*, *E. salmonophloia*, *E. loxophleba and Corymbia calophylla;* in planted *E. gomphocephala, E. conferruminata, E. platypus*, and *C. ficifolia*, and in several eastern states eucalypt species grown in WA. Samples have been sent to Dr Hanold in Adelaide to be tested for MY-RNAs.

- MY-RNAs have been detected in symptomatic trees of those species for which the present molecular test can be used – *E. camaldulensis*, *E. salmonophloia*, *E. loxophleba, E. gomphocephala* and *Corymbia calophylla.*
- MY symptoms have still not been seen in undisturbed forest in WA. Symptoms appear to be confined to trees on roadsides or in urban parks and gardens. However, MY-like symptoms were seen in 2 areas of a eucalypt revegetation planting on a farm; a second similar report (from a different shire) is to be investigated.
- Article published in Winter 2002 edition of *Landscope*: 'Mundulla Yellows – a new tree-dieback threat', by D Hanold, M Stukely and JW Randles. This provides an overview of what is known about MY, and the priorities for research so that management strategies for MY can be developed as soon as possible. Reprints have been widely distributed and the article has been extracted in 2 other publications. It was used as a Poster at the Australian Institute of Horticulture National Conference 2002 (Sydney, 27-28 September), and is included in the University of Adelaide website.
- M Stukely has been appointed to represent DCLM and WA on the national Mundulla Yellows Task Group (MYTG) that will be reporting to LWBC in Nov 2003. I have attended all formal meetings of the MYTG, and in May 2003 a Risk Management Workshop, and have made a significant contribution to the preparation of its reports.
- While in SA in Feb 2003, I took the opportunity to visit MY sites in the Upper South-East and the Barossa with Dr Hanold, and met with concerned local people. Local radio stations and the newspaper reported interviews with Dr Hanold and myself.

Future direction(s)
- Monitoring of existing and new occurrences of MY in WA needs to continue (low-key).
- Priority must be given to investigating any reports of MY-like symptoms associated with either *E. globulus*, oil mallees, other plantations, or nurseries (or their surrounds), or with vegetation in areas of high conservation value. [This work can be linked to the VHS.]
- More DCLM and FPC staff in relevant areas need to be informed of what to look for in identifying possible MY symptoms, and be encouraged to report them.
- Additional transects are to be established in WA for monitoring spread of MY from known infections to healthy vegetation (as part of Dr Hanold's program).
- Collaboration with and assistance to Dr Hanold should continue. DCLM is an Industry partner with University of Adelaide in an ARC Linkage Grant application (2003).
- Once a rapid test for MY has been developed and proven, it should be applied in WA without delay (through the DCLM Vegetation Health Service). There is likely to be an ongoing need for screening of planting stock from nurseries, as well as for the routine testing of suspect symptomatic trees, as elements of future disease management.
- Small-scale trials could be carried out here (in collaboration with Dr Hanold) to examine aspects of MY such as transmission (by seed, pollen, insects, other soil vectors?), host range, and the effects of environmental factors such as nutrition, herbicides, and other stresses. Funding for these will need to come from DCLM/FPC.

DCLM Region(s)
Swan, South West, Midwest, Wheatbelt, South Coast, Warren.

IBRA Region(s)
Swan Coastal Plain, Geraldton Sandplains, Jarrah Forest, Avon Wheatbelt, Esperance Plains, Warren.

The long-term effect of various fire regimes on floristics of Jarrah forest understorey species

SPP # 93/099

Team members
B Ward (0.25), G Liddelow (0.1); Total (0.35).

Aim
To determine the optimal fire regime for providing protection and maintaining biodiversity in understorey

vegetation of the Jarrah forest.

Summary of progress
- This research is yielding valuable information about the post-fire responses of a wide range of taxa. Ongoing measurement of these plots is vital to trace fire impacts and regular and repeated burning of the treatments is also essential to the success of this study.
- Spring treatments for this year were not done as drying trends were too rapid producing the worst fire season for 40 yrs. The treatments involved were 3 plots at Lindsay block, which were postponed until Spring (Nov – Dec) 2003.

Future direction(s)
- Maintain fire treatments.
- Measure floristics for all plots in spring 2005.
- Preliminary analysis of data following floristic measurements in 2005 and review study.

DCLM Region(s)
Warren, South West.

IBRA Region
Jarrah Forest.

Ecology of the Ngwayir (*Pseudocheirus occidentalis*) and Koomal (*Trichosurus vulpecular*) within the Jarrah forest

SPP # 02/0002

Team members
A Wayne (1.0), C Ward (0.5), J Rooney (0.5), C Vellios (0.5); Total (2.5).

Aim
- To compare survey methods to identify the most effective means of detecting individuals.
- To investigate what factors explain the distribution and abundance of these species.
- To describe their life histories (population demographics, fertility and development).
- To examine the habitat selection and preferences of these possums for food and shelter by comparing what they have available with what they use

Summary of progress
- Field work associated with the examination of the effectiveness of different survey methods has been completed. Data analysis is nearly completed and a drafting of a paper for publication has commenced.
- A radio-collared case study cohort of Nwayir and Komal at the 'Orient' study site in Chariup block, Perup has been established. The numbers of individuals within these cohorts are maintained at approximately 20 individuals each at any one time. These animals have been regularly radiotracked (every 4th week) since July 2002 to collect diurnal and nocturnal habitat selection data.
- The radio-collared Nwayir cohort has experienced an unexpected high level of mortality through predation over the last 11 mths. A total of 40% of the 42 ngwayir that have been radio-collared to date have died. Both foxes and cats appear to be the main predators involved.
- Life history data on the Nwayir and Komal populations at the 'Orient' study site have been regularly collected (at least once every 2 months) since June 2002.
- The preparatory work for an examination of the factors explaining the distribution and abundance of possums in the Perup jarrah forest is well underway. Approximately 90 prospective sites have been selected and identified in the field. Site preparations are planned during May and June in advance of possum surveys commencing on these sites beginning in July 2003.

Future direction(s)
- Habitat selection and life history data on possums will continue to be regularly collected at the 'Orient' study site until Nov 2003. Associated habitat surveys are planned for Jan – March 2004.
- The fauna surveys associated with the distribution and abundance study will be conducted between July

2003 and Jan 2004.
- All field work will be completed by March 2004.
- A paper on the results of the survey method trials will be submitted by July 2004.

DCLM Region
Warren.

IBRA Region
Jarrah Forest.

Characteristics of hollow-bearing Jarrah (*Eucalyptus marginata*) and Marri (*Eucalyptus calophylla*) trees and coarse woody debris (CWD), their use by selected species of fauna, and the effect of logging-and-burning Jarrah forest on them

SPP # 93/0095

Team member
K Whitford (0.2); Total (0.2).

Aim
- To develop a method of describing the dimensions of hollows used by fauna.
- To describe the range of hollow sizes used by hollow dependant species from the Jarrah forests.
- To establish the relationship between tree size and tree age for Jarrah and Marri trees.
- To determine what types of trees and crowns bear hollows in the Jarrah forest and where in the tree crowns these hollows occur.
- To examine the distributions of sizes, shapes, and orientations of these hollows.
- To determine the ages of trees bearing hollows.
- To determine if hollows can be reliably detected from the ground.
- To examine the relationship between tree and crown attributes and the abundance of hollows.
- To develop predictive relationships for hollow occurrence and provide descriptions of the type of trees most likely to bear hollows.
- To determining the relative size of hollows used by all hollow dependant fauna species in the Jarrah forest and the minimum age and size of trees bearing hollows potentially suited to these fauna species.
- To identify fauna species most likely to be threatened by any future shortage of suitable hollows.
- To examine the occurrence of hollows suited to the species most at risk.

Summary of progress
- 5 papers published from this research.
- One additional paper currently in review.
- Landscope article published.

Future direction(s)
The potential for applying of this research to broadscale management of hollows is currently being investigated.

DCLM Region(s)
South West, Warren.

IBRA Region
Jarrah Forest.

Evaluation of key soil indicators of sustainability in Australian Mediterranean forests (Indicators 4.1d, 4.1e)

SPP # not yet approved

Team member
K Whitford (0.2); Total (0.2).

Aim
- To investigate the sensitivity of soil organic matter as an indicator of ecologically sustainable forest management in Western Australian Jarrah (*Eucalyptus marginata*) and Karri (*E. diversicolor*) forests.
- To examine the impact of fire on organic carbon and clarify the effect of fire on N and organic carbon in the forests of south-western Australia.
- To establish some base data on the intensity and extent of soil disturbance in the Jarrah logging coupes using a nationally agreed survey protocol for estimating soil disturbance.
- To development and refine the survey techniques proposed in the nationally agreed survey protocol for estimating soil disturbance.
- To compare survey techniques for determining snig track area.
- To examine the commonly expressed assumption that only minor soil compaction and disturbance occur in jarrah logging coupes.
- To examine techniques for measuring bulk density in gravelly forest soils and identify appropriate measurement technique for these soils.
- To examine the effects of corer size on the measured fine earth and total bulk density, and determine if this is affected by soil gravel content.
- To examine the relationship between soil disturbance class, bulk density, and soil shear strength.
- To report and compare the extent of disturbance on 3 faller's blocks in the Northern jarrah forest of south-west WA.
- To investigate the impact of snig track compaction on tree and stand growth in the Karri forest.
- To determine the size of any growth reduction occurring on snig tracks, and the size of any compensating growth increase adjacent to snig tracks.
- To examine the bulk density of the soil on and about the snig tracks to identify the threshold value at which soil compaction causes a reduction in tree growth.

Summary of progress
- Field work and data analysis completed.
- Final report to funding body submitted.
- Two manuscripts from this work have been prepared for publication and are in internal review.
- Advice was provided during the preparation of the current Forest Management Plan.
- Advice provided to the Conservation Commission regarding the setting of soil moisture and soil disturbance limits for logging activities.
- Contributed to pool of knowledge of soil properties, soil disturbance, and the effect of logging and forest management on soil properties.

Future direction(s)
Submit 2 manuscripts that have been prepared for publication.

DCLM Region(s)
South West, Warren.

IBRA Region(s)
Jarrah Forest, Warren.

Effect of stand density and fertilizing on seed-fall. Exp B. Establishment of Jarrah (*Eucalyptus marginata*) in shelterwood areas and on dieback 'graveyard' sites

SPP # 93/0094

Team member
K Whitford (0.3); Total (0.3).

Aim

- To determine the effect of stand density and fertilizer on the quantity of seed-fall in the Jarrah forest.
- To examine seasonal variations in seed-fall.
- To examine the production and loss of buds, flowers, and capsules to increase understanding of the seed production cycle.
- To provide knowledge of seed-fall relevant to improving the management and regeneration of shelterwood logged Jarrah forest.

Summary of progress

- Field work completed.
- Laboratory work completed – seed counting, drying and weighing of seed fall collections from 1996.
- Data analysis completed.
- Final SPP report written and in internal review.
- Manuscript for external publication written and in internal review.

Future direction(s)

- This SPP is no longer active and no future work is currently planned in this area.
- Submit manuscript for publication in refereed journal.

DCLM Region
South West.

IBRA Region
Jarrah Forest.

The impact of repeated defoliation on the wood growth of Jarrah saplings

SPP # 24/86

Team members
A Wills (0.04), T Burbidge (0.01), I Abbott (0.01); Total (0.06).

Aim
To document stem growth and survival of annually 100% defoliated versus undefoliated Jarrah ground coppice in a regenerating Jarrah coupe.

Summary of progress

- Sixteenth year of measurement completed
- Final measurements were entered into the database and a paper drafted reporting observations.
- Within 3 yrs, annual 100% defoliation resulted in almost complete suppression of stem diameter growth. Despite up to 15 yrs of repeated defoliation, no plants were killed, although the main stem from which measurements were taken did die in an increasing proportion of cases over time. After 15 yrs about half the defoliated plants had died back to below the measuring point. Death of stems did not appear to be related to less than usual winter rainfall in some years. From the resilience demonstrated to artificial defoliation, which is more severe than defoliation encountered in natural conditions, understorey jarrah plants appear to be capable of withstanding repeated annual defoliation by fire or insects for extended periods.

Future direction(s)

- Project completed.
- Paper submitted to Australian Forestry.

DCLM Region
Swan.

IBRA Region
Jarrah Forest.

Control of Jarrah leafminer: selective retention of JLM resistant trees and ground coppice in a demonstration forest plot

SPP # 93/97

Team members
T Burbidge (0.01), A Wills (0.01), I Abbott (0.01); Total (0.03).

Aim
To provide a visual demonstration of improvement in stand health and productivity by management practices.

Summary of progress
Site inspected, no maintenance required.

Future direction(s)
- Carry out coppice removal on treated areas, as required.
- Demonstration that selective retention of Jarrah leafminer resistant trees is not a practical silvicultural tool for stand improvement as there is little establishment of regenerating seedlings to provide recruitment of resistant regeneration. Leafminer outbreaks have abated since the demonstration coupe was established. When JLM outbreaks again in the area, this plot should provide striking visual evidence of the value of selective removal of susceptible stems in reducing population size of the insect.

DCLM Region
South West.

IBRA Region
Jarrah Forest.

Landscape and fire management interactions and their effects on distribution of invertebrate biodiversity

SPP # 01/03

Team members
A Wills (0.3), I Abbott (0.01); Total (0.31).

Aim
- To document the effects of topography on the distribution and abundance of invertebrates in Jarrah forest.
- To determine whether landscapes provide natural fire and climatic refuges in the Northern jarrah forest.

Summary of progress
Sorting of ants to morphospecies level completed and data entered into database.

Future direction(s)
- Complete sorting of beetles, spiders and other orders to morphospecies level. Assemble database and analyse.
- Write up and publish in refereed journal.

DCLM Region
Swan Region.

IBRA Region
Jarrah Forest.

BUGBASE: the database of the DCLM conservation terrestrial invertebrate collection

Core Function

Team members
T Burbidge (0.5), I Abbott (0.01); Total (0.51).

Aim
To facilitate DCLM and public access to information held in the DCLM terrestrial invertebrate collection, managed by the Science Division.

Summary of progress
Data entry (funded by Gordon Reid Foundation for Conservation under administration of Lotterywest) substantially complete with in excess of 15 000 records.

Future direction(s)
- Verification audit of data integrity to be completed.
- Development of an internet interface for public use to be completed.

Landscape-scale species richness of earthworms in the Porongurup Range, Western Australia: influence of aspect, soil fertility, and vegetation type

Team members
A Wills (0.3), I Abbott (0.01); Total (0.31).

Aim
To document the diversity and distribution of the earthworm fauna of the Porongurup Range National Park.

Summary of progress
- The diversity of earthworms in this 26 km^2 remnant of native vegetation was examined. Comparison of α diversity within the Porongurup Range to diversity of other earthworm faunas demonstrates the sampling intensities required to adequately sample regions of 10^0-10^1 km^2.
- In addition β diversity patterns were examined in relation to habitat as described by landscape context, vegetation cover and soil characteristics. Species accumulation in samples from the northern aspect of the range was less than expected from a random distribution of species. Combined Karri, Marri and Karri vegetated sites supported significantly more earthworm species on the southern aspect of the range than expected from accumulation in randomly ordered samples. Sites carrying Jarrah as the only dominant canopy had fewer earthworm species than would be expected from accumulation in randomly ordered samples. Jarrah overstorey sites and southern aspect Karri sites correspond to extremes in a continuum of soil and landscape characteristics.

Future direction(s)
Project completed. Paper has been accepted for publication in the refereed journal Biology and Fertility of Soils.

DCLM Region
South Coast.

IBRA Region
Jarrah Forest.

Vegetation Health Service

Core Function

Team members
M Stukely (0.4), J Webster (0.6) + N D'Souza (to 6 Dec 2002); J Ciampini (0.4) = 100% FTE (time-share TO

position); Total (1.4).

Aim

- To provide a dedicated service for the detection and identification of Phytophthora species from samples associated with logging and mining activities, management of the State's forest and conservation estate, private industry and research. The service is free of charge to all DCLM and FPC personnel involved in the management of dieback disease for the conservation of biodiversity within Western Australia.
- To provide a service which is also available to external customers at a standard fee of $77 (incl. GST) per sample.
- To provide advice to assist Departmental personnel and the public with other plant disease problems in parks and reserves, forests, plantations and nurseries.

Summary of progress

A total of 1 205 samples were processed for Phytophthora in 2002-2003. These came from a variety of sources, as shown below:

Manjimup FMB	245
Bunbury FMB	123
Swan FMB	115
Other DCLM Districts	35
FPC	2
Glevan (Consultants)	245
Alcoa	424
Private	14
Watkins (Consultants)	2
TOTAL	**1205**

- 75 Phytophthora isolates (other than *P. cinnamomi*) were subcultured for identification to species.
- A new, as yet unnamed, Phytophthora species has been isolated from samples sent from 2 distinct locations in the South-west in 2002. Cultures were sent to the UK for testing and DNA analysis.
- Advice and consultations concerning other plant diseases were given to various staff and members of the public as required, including several Naturebase inquiries.

Future directions

- The VHS will continue to verify field dieback-interpretation by testing of soil and plant samples.
- Efforts will be made to encourage Departmental staff to make more use of the VHS, particularly in conservation areas where regular sampling is necessary to give accurate, up-to-date information about the Phytophthora status of the area. This information is crucial for the conservation of rare and endangered species that are Phytophthora-susceptible.
- The VHS and culture collection will be available for use by the newly opened Centre for Phytophthora Solutions and Management.
- Further work will be done on the Phytophthora sp. nov., with a view to publishing this.
- The Phytophthora Culture Collection will be maintained and expanded, and available to researchers.
- Testing for Mundulla Yellows disease in WA will be co-ordinated through the VHS, when a routine diagnostic test becomes available.

DCLM Region(s)

Midwest, Swan, South West, Warren, South Coast, Wheatbelt.

IBRA Region(s)

Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Warren, Esperance Plains, Avon Wheatbelt.

PERTH OBSERVATORY

Group Manager: Dr James Biggs

EDUCATION
Core Function

Team members
J Biggs (0.2), P Birch (0.35), R Martin (0.2), A Verveer (0.3), J Bell (0.2), A Williams (0.25), J Pearse (0.3), T Smith (0.5), G Lowe (0.5), D Johns (0.4); Total (3.2).

Aim
- To provide relevant and timely education services.
- To demonstrate science in action.
- To facilitate the development of the tourism potential of astronomy.

There is a significant demand for astronomy education services from many different groups and individuals within the community. Conduct of this project directly addresses the State Government's 'Innovate WA' Policy objective of *'strengthen and improve the educational and research capacity of the state'*.

Summary of progress
Key activities in this core function include:
1. Provision of lectures, talks, workshops etc.
2. Provision of astronomy activities for visitors; star viewing, guided tours, astronomy field nights etc.
3. Measurement of customer satisfaction and perception of quality.
4. Create equipment for daytime astronomy.

Most of the milestones for these activities involved the maintenance of the level of activity and user participation. Activity 1 had an additional milestone of implementation of a new activity – an off-site PC-based presentation capability, and activity 2 had the additional milestones of the implementation of star viewing for the disabled and the implementation of a new booking system for visitors.

Acquisition of the portable data projector and laptop PC enabled the successful implementation of off-site PC-based presentations. The equipment acquired by the Perth Observatory Volunteers Group to facilitate the participation of the disabled in star viewing was formally dedicated on 18 Aug 2002, and has been is steady use over the year. Also, a new visitors booking system has led to greater efficiency in this element of Observatory operation. Activity 4 achieved its milestone with the acquisition of an H-alpha-telescope that is used show the Sun to daytime visitors. It was also successfully used during the Observatory's total solar eclipse expedition to Ceduna, SA, on 4 Dec 2002.

A noticeable improvement was registered in Daytime Guided Tours attendance, and this lifted the total attendance to above that of the previous year. However, the attendance milestones for Astronomy Field Nights and talk/lectures were not achieved. This reflects the fact that attendance is somewhat beyond our control. Furthermore, the Star Viewing Night attendance was adversely affected by persistent inclement weather. The percentages of satisfied customers, those with raised astronomy awareness and perception of educational quality were still very high and not statistically different from previous years.

Activity	2002/2003	2001/2002
Star Viewing Nights	178	185
Night Visitors	5653	6107
Daytime guided tours	146	122
Day visitors	4119	3607
Astronomy Field Nights	23	27
Field Night attendance	2496	2833
Lectures and Talks	82	89
Talk attendance	1990	2899
Student consultations	86	57
Customer satisfaction (star viewing and guided tours)	94%	94%
Astronomy awareness raised	95%	95%
Educational quality	98%	96%

Future directions
It is planned to continue the current activities, with similar milestones.
Additional milestones include:

- Activity 1 - Conduct special viewing sessions during August and September for the 2003 opposition of Mars, and conduct a basic astronomy course for the public,
- Activity 2 - Improvement of the PC presentation with a special focus on Mars,
- Activity 4 - Develop and market astronomy education resources - creation of a new educational resource – teacher resource kit, and manual operation of Project Astronet (internet telescope).

INFORMATION

Core function

Team members
J Biggs (0.2), P Birch (0.2), R Martin (0.1), A Verveer (0.1), J Bell (0.1), A Williams (0.1), J Pearse (0.1), T Smith (0.1), G Lowe (0.1), D Johns (0.4); Total (1.2).

Aim
To provide relevant and timely astronomical information.

There is a significant demand for astronomical information from many different groups and individuals within the community. Furthermore, State law requires provision of certain astronomical information. Conduct of this project addresses the State Government's 'Innovate WA' Policy objective of *'strengthen and improve the educational and research capacity of the state'*.

Summary of progress
Key activities in this core function include:

1. Provision of astronomical information in response to enquiries (via, telephone, email etc).
2. Communication with the media regarding astronomical issues and events.
3. Provision of up-to-date information resources.
4. Provision of astronomical information via the WWW.
5. Promotion of Perth Observatory astronomy.
6. Restoration and preservation of Perth Observatory archives.

Milestones for Activities 1, 2 and 4 involved the maintenance of the level of activity and user participation. The table below indicates that whilst the levels were not always maintained they were still close. This was deemed acceptable especially given the Observatory-wide emphasis on the increase in visitor attendance in the Education core function. Furthermore, customer surveys suggest that the quality of Observatory information remains high and response to information requests remains timely.

The provision of up-to-date information resources had mixed success in achieving its milestones. Volunteers used the new library database software and a poster that highlights the Observatory's activities was created. However, funding limitations hampered the creation of a part-time promotion position. These last 2

milestones were also relevant to Activity 5.

Perth Observatory recently resumed full responsibility for the production of an annual astronomy almanac for WA, and this forms part of Activity 3. This arrangement has the virtue of being more responsive to the needs of the local users of this resource. The 2003 almanac was the first in the new format and user feedback has been uniformly positive.

Volunteers continued to provide assistance in the preservation and restoration of Observatory archives. Thus, the milestone for Activity 6 was also attained.

Future directions
The activities and milestones remain essentially the same for fiscal 2003/04. The activities are detailed above and most milestones entail the maintenance of the level of activity at least at the previous year's level. Activities 3 and 4 include the operation of internet telescope (should Curtin University provide internet access).

Activity	**2002/2003**	**2001/2002**
Telephone enquiries	9,872	11,138
Information line	1,462	1,001
Email enquiries	562	535
No. talks, lectures etc	82	89
Talk attendance	1,990	2,899
Consultations	86	57
Newspaper, radio & TV	136	149
www page hits	1,116,079	875,783
Positive responses to 'quality' question in customer surveys	98%	98%
Satisfaction of information requests as they occur	98%	99%

RESEARCH

Core function

Team members – (details are provided under each SPP, below)

Aim
To provide astronomical research in the following areas:

- Monitoring brightness changes in stars, comets, gravitational lensing events and other celestial bodies, and participate in their further study.
- Determining positions of minor bodies (asteroids and comets) and targets of opportunity and forwarding these to the International Astronomical Union for publication and dissemination.
- Searching for extra-galactic supernovae in low-redshift spiral galaxies.
- Conducting spectrographic observations of relatively bright celestial objects.
- Testing the suitability of appropriate Western Australian sites for astronomical observations.

This program directly addresses the State Government's 'Innovate WA' Policy objective of *'strengthen and improve the educational and research capacity of the state'*, and with a recommendation in the Final Report of the (Australian) Innovation Summit Implementation Group; Innovation: Unlocking the Future (2000), *'Publicly funded basic research plays an important role in supplying much of the knowledge, skills and new ideas critical to a competitive and innovative economy.'*

Summary of progress
Progress in individual projects is detailed below for each SPP. Observatory staff published a total of 3 papers in refereed international journals and another 2 in minor publications (poster papers, abstracts etc). 100% of referred papers submitted were published (100% in 01/02) and 91% of astronomical targets of opportunity were effectively studied (68% in 01/02).

Future directions
The future direction for each SPP is discussed below.

Variable star observations
SPP # 98/0009

Team members
J Biggs (0.01), P Birch (0.1), R Martin (0.01), A Verveer (0.2), A Williams (0.01), J Pearse (0.02), T Smith (0.03), G Lowe (0.03); Total (0.23).

Aim
To monitor continuous brightness of variable stars. This will lead to an increased knowledge of the structure and processes within stars.

Summary of progress
- No observations were made in 2002/2003, as no suitable targets were available.
- Two papers were published, one concerned pulsating DB White Dwarfs;
  G. Handler, and 49 others, P. V. Birch, and 18 others. 2003. 'Amplitude and Frequency Variability of the pulsating DB White Dwarf stars KUV 05134+2605 and PG 1654+160 Observed with the Whole Earth Telescope', Monthly Notices of the Royal Astronomical Society, 340, 1031 - 1038.,

  and the other concerned the optical and orbital parameters of binary stars:
  Kawka, A., Vennes, S., Kock, R. & Williams, A., 'Optical Observations and Orbital Parameters of the Close DA plus dMe Binaries BPM71214, EUVEJ0720-31.7, BPM6502 and EC13471-1258', 2002. Astronomical Journal, 124, 2853-2867.
- A paper detailing the results from the combined observations (in Nov 2000) of 12 observatories in conjunction with the Whole of Earth Telescope Project (WET) of the variable star HR1217 was submitted for publication.

Future directions
Participation in international variable star monitoring programs will continue as time and resources permit, with the milestone remaining 'the successful observations and reduction of data for publication'. However, the main target set for this continued program in 03/04 is too faint for Perth Observatory telescopes to monitor.

Imaging and spectrophotometry of comets
SPP # 98/0010

Team members
J Biggs (0.01), P Birch (0.1), R Martin (0.01), A Verveer (0.2), A Williams (0.01), J Pearse (0.02), T Smith (0.03), G Lowe (0.03); Total (0.23).

Aim
- To monitor cometary brightness changes in specific wavelength bands.
- To observe comets over a wide range of heliocentric distances both pre-perihelion and post-perihelion.
- To image the coma and tail(s) for specific structural features. This will facilitate a comparison between the various cometary families and build a database of cometary properties.

Summary of progress
- No cometary observations were made in 2002/2003, as no suitable comets were available. Observations can only be made when comets are suitably accessible to Perth Observatory equipment.
- One abstract was published concerning Comets C/2000 WM1 (LINEAR) and C/2002 C1 (Ikeya-Zhang); Schleicher, D. G., and Birch, P. V. (2002), 'Narrowband Photometric Results for Comets LINEAR (2000 WM1) and Ikeya Zhang(2002 C1)', BAAS, 34, 853.

Future directions

- Comet Hale-Bopp was the subject of a long-term study at different locations, and a paper discussing this is in preparation.
- Newly discovered comets will continue to be observed as they become available in the Southern Hemisphere. The next planned comprehensive observing program is for late 2003, when the bright Comet C/2001 Q4 (LINEAR) will be available. Further observations will be made of Comet 9P (Tempel) in late 2004/early 2005 when it becomes available in southern skies in the lead up to the Deep Impact Mission.
- Commissioning of an automated focuser for the PLAT should begin in 2003 and facilitate an increased number of observations.

Imaging and CCD photometry of transient and variable sources

SPP # 98/0011

Team members

J Biggs (0.04), P Birch (0.01), R Martin (0.01), A Verveer (0.02), A Williams (0.01), J Pearse (0.02), G Lowe (0.03), T Smith (0.03); Total (0.27).

Aim

To image newly discovered celestial objects and/or poorly known variable sources, so as to increase knowledge of Solar System objects, discover new Solar System objects, and increase knowledge of the structure and processes within stars.

Summary of progress

- In 2002/2003, no observations were made as part of scientific collaborations but some monitoring of about 15 known and suspected variable stars we undertaken. The data acquired were processed to facilitate comparison with further observations.
- Also, a study was conducted to ascertain whether a large database of photometric measurements of stars was affected by occultations by Solar System objects, such as asteroids. The results were not conclusive and further work is required.

Future directions

Suitable targets will be observed as time and resources permit.

Astrometry of minor planets, comets and targets of opportunity

SPP # 98/ 0012

Team members

J Biggs (0.20), P Birch (0.01), R Martin (0.01), A Verveer (0.02), A Williams (0.01), J Pearse (0.02), G Lowe (0.24), T Smith (0.24); Total (0.75).

Aim

- To measure the position of minor bodies, so as to determine their orbits. This is of fundamental interest in itself in order to determine the origin, history and fate of each object. Also, knowledge of an object's position facilitates other specialized types of observation (and these not need be restricted to the visible part of the electromagnetic spectrum).
- To measure the position of targets of opportunity such as supernovae in order to confirm their existence as well as facilitate follow-up observations with other instruments.

Summary of progress

- In 2002/2003, a total of 402 (278 asteroid and 124 comet) minor body positions were published. Six of these were confirmation observations for a newly discovered Near Earth Object (NEO), and 165 were useful observations of 35 other NEOs necessary to refine their orbits.
- Also, observations progressed in a search for asteroids in the Lagrangian points of the Earth's orbit. The search we have undertaken is the most extensive conducted to date, but no asteroids of this type brighter than V~17.5 were discovered. This implies their number density is less that about 0.3 asteroids

per square degree.
- One paper was published on our unsuccessful attempt to recover a potentially hazardous asteroid:
  - Biggs, J. D. & Slivkoff, M., 'A Search for the Potentially Hazardous Asteroid 1999 OX4: Implications for a Possible Encounter in 2014', 2002. Publications of the Astronomical Society of Australia, 19, 422-424.
- Fortunately, this null detection means that it will not have a close encounter with the Earth in 2014.
- Work proceeded on the integration of the telescope and camera control functions onto one PC.
- Also, an application for a grant from the Royal Astronomical Society of London was submitted. Even though it was ranked highly by some referees, funding was unsuccessful.

Future directions
Monitoring of NEOs will continue with the milestone an increased number of published positions. Further integration of telescope and camera control onto one PC will be progressed. Also, the search of the Earth's Lagrangian points for asteroids will be continued.

Monitoring gravitational microlenses
SPP # 98/0013

Team members
J Biggs (0.01), P Birch (0.01), R Martin (0.25), A Verveer (0.03), A Williams (0.30), J Pearse (0.03), G Lowe (0.03), T Smith (0.03); Total (0.59).

Aim
- To use precise light curve measurements in order to characterize the statistics and kinematics of Galactic microlensing events.
- To detect extra-solar planets.
- To gather information on the stellar population in and around the Galactic Bulge.

This is achieved through an international collaboration - PLANET – with 19 members in 9 countries. Access to telescopes in Perth, South Africa, Chile, Tasmania and NSW allows 24-hour monitoring during the bulge season (April-August).

Summary of progress
- Access to 200 hours of 2.2m telescope time during the 2002 bulge season at the European Southern Observatory has seen the PLANET project add searching for planetary transits (where a planet blocks out the light of the star it orbits, for a few hours at a time) to the gravitational microlensing technique. Analysis of the 2.2m telescope data is progressing in Paris. However, this will take some time because of the large volume of data (over 128Mb of data per image, every 1-2 minutes, for ~200 hours).
- In Perth, fully unattended operation has become the norm for all observing over the past year, but only later than around midnight, due to the need for manually refocusing the telescope as temperatures fall during the night. Development of a new scheduler is progressing, and has been run in trial form for ~20 nights. It can manage PLANET observing, as well as other tasks like the Supernova Search. While the telescope is running, members of the PLANET group (still awake, in different time zones) can directly alter the object priorities and sample rates in real time, responding to anomalous behaviour in any event. Perth is the only PLANET telescope using any form of automated observing.

Future directions
The April-Aug 2002 and the June-Aug 2003 bulge seasons included many prime events, and data analysis is progressing. Several papers are being prepared, and one is in press.
Commissioning of an automated focuser for the PLAT should begin this year and facilitate an increased number of observations.

Supernova search
SPP # 98/0014

Team members
J Biggs (0.01), P Birch (0.01), R Martin (0.3), A Verveer (0.02), A Williams (0.25), J Pearse (0.02), G Lowe (0.03), T Smith (0.03); Total (0.67).

Aim
- To contribute to the broader study of supernovae by employing methodical search techniques to detect supernovae at early stages of their evolution.
- To make an independent determination of the supernovae rates within late spiral galaxies.
- To do additional research on the supernovae found. For example collect photometric light curves of supernovae discovered by Perth Automated Supernova Search.

The Perth Automated Supernova Search is a search for extra-galactic supernovae in low redshift spiral galaxies. The search uses the 61 cm Perth Lowell Automated Telescope (PLAT) at the Perth Observatory.

Summary of progress
- Supernova photometry: A basic data reduction pipeline for the photometric reductions was developed, however, this still needs more work. Photometric data was acquired for 3 supernovae.
- Supernova search: The system continues to recover supernovae but has not discovered any new supernovae because of an increase in the number of automated and semi-automated supernova searches now observing the southern skies. If the system fails to detect any events over the next year then it will be downgraded to a background program.
- Gamma Ray Burst (GRB) supernovae: This line of work was undertaken in order to support an ANU PhD student (Paul Price) whose work was adversely affected after the destruction of Mt Stromlo Observatory by fire. A substantial effort went into developing software that automatically controls the PLAT in an effort to promptly detect optical counterparts of GRBs (detected by orbiting satellites) in response to email notification from the GRB Notice Centre
- Unattended Operation: Utilization of the data from the Observatory cloud detector in the automated observing program has resulted in a 3-fold increase in the number of images collected by the PLAT this year. Software to automatically schedule events for observation is now being developed (by Andrew Williams).

Future directions
Additional programs for supernova photometry and GRB monitoring that can run in parallel with the supernova search will be developed.

Astronomical evaluation of sites in WA for observation
SPP# 00/0006

Team members
J Biggs (0.02), P Birch (0.01), R Martin (0.06), A Verveer (0.02), A Williams (0.01), J Pearse (0.02), G Lowe (0.01), T Smith (0.01); Total (0.16).

Aim
To involve the testing of appropriate Western Australian sites regarding their suitability for astronomical observations. This will provide information necessary for the planning of future facilities.

Summary of progress
- Work priorities have meant that no progress was possible in 2002/2003.
- In order to progress this project an application for a grant (to fund a part-time research assistant) from the Royal Astronomical Society of London was submitted, but was unsuccessful.

Future directions
Future key activities include the monitoring of the seeing at Bickley for a further 5 nights, and, the output of a preliminary report regarding the analysis of observations at one remote site.

STUDENT PROJECTS – PROGRESS REPORT

The following reports were supplied.

Scientist: S Halse
Student: W Kay

Project title
Population ecology of estuarine crocodiles, *Crocodylus porosus*, in the Kimberley region of Western Australia.

Progress Report
The project is investigating 3 aspects of crocodile biology:

1. Population genetics: skin tissue was collected so that DNA could be extracted to investigate how closely related crocodile populations inhabiting different river systems are to one another. 123 tissue samples were collected from the King (50) and Ord (40) Rivers in the east Kimberley and from the Glenelg (33) River in the west Kimberley. Most of the samples have been analysed but some samples from the Glenelg River await analyses.

2. Crocodile movements: A radio-tracking study was implemented to investigate patterns of crocodile movements. VHF radio tags were attached to 16 crocodiles ranging in size from 2.1 to 4.3 m. Over 440 fixes were obtained over a 12 mth period. This is the first successful tracking study of either species of crocodile found in Australia.

3. Population biology: a mark-recapture study was initiated on the King River to examine the population dynamics of this particular river system. 162 crocodiles were caught, marked and released; and 59 individuals were recaptured at least once during the study for a total of 118 recaptures. As part of this study, the potential of osteoderms for indirectly aging crocodiles using skeletochronology will be examined.

The fieldwork and data collection phase of this project was completed in May 2003. I am now based in Brisbane at the University of Queensland analysing and writing up the data.

Publications to date
Kay, W. R. (submitted) Crikey: a new method for attaching electronic devices to crocodilians. *Herpetological Review*.

Scientist: S Halse
Student: E Lowe

Project title
Macroinvertebrates and diatoms as indicators of acidity in wetlands of Western Australia.

Progress Report
The project is examining the merits of diatoms and macroinvertebrates as biomonitors of acidity. The main aim of the project is to identify assemblages of diatoms and invertebrates that are indicative of acidic waters. A further aim is to compare the effectiveness of macroinvertebrates and diatoms as indicators of pH change. 30 wetlands in the south-west of Western Australia were sampled seasonally over a 12 mth period. 20 of these wetlands have been selected for use in the final study. Sampling included diatoms and macroinvertebrates and the measurement of physico-chemical parameters.

Each of the diatom samples has been processed and counted. At present, the main focus of the project is on the counting and identification of the invertebrates. An invertebrate voucher collection has been established and is being updated as the work progresses. The invertebrate analysis is expected to continue until Sept 2003. A draft of the Introduction and the Methods chapters for the project is underway, as is the preparation of the physico- chemical data for multivariate statistical analysis. Species data will be analysed on completion of identification. The anticipated thesis submission date for this project is March 2004.

Scientist: S Halse
Student: A Mackintosh

Project title
The ecology of stygofaunal ostracods in the Pilbara, WA.

Progress Report
Currently there are sparse scientific data on the distribution and diversity of subterranean fauna in the Pilbara region of North Western Australia. However, 5 stygofauna species have been declared as Specially Protected (Threatened) fauna under the Wildlife Conservation Act 1950 (DRD, 1999). So far we have improved on the sampling methods employed by previous researchers and are now recovering considerable amounts of new data concerning the groundwater fauna in the Pilbara.

Ostracods allow precise chemical correlations to be made between the groundwater of the system and their life history. By identifying key trace elements and isotopes in the ostracods carapace we can relate the animals to particular groundwater systems. As rock type is an important contributor to the chemistry of groundwater we can begin to identify where a species migrated.

At present I am working on the identification of key species and their communities to work out which assemblages will be important to the study. I am also processing the chemical data we already have to identify limiting factors within the groundwater in terms of ecological requirements.

Publications to date
None

Scientist: S Halse
Student: J-M Benier

Project title
An investigation of the importance of farm dams in the wheatbelt of Western Australia for the conservation of aquatic macroinvertebrates.

Progress report
All fieldwork and species identification are complete and I am in the write-up phase.

I am working towards completion of the thesis by end of July 2003. I have completed the body of the first 5 chapters. These are the Introduction, Methods including site descriptions, autumn sampling results, spring sampling results and rehydration sampling results.

Publications to date
None.

Scientist: S Halse
Student: K Sutcliffe

Project title
Conservation status of some aquatic insects in south-western Australia.

Progress Report
This PhD project is now complete and the PhD has been submitted (although no copy has been provided to

DCLM as yet). An abridged abstract is reproduced below.

Freshwater ecosystems in south-western Australia have been extensively altered since European with unknown effects on aquatic fauna, particularly invertebrates. Future changes in the composition of aquatic fauna will also go undetected unless current distributions of existing species are well documented.

Current distributions and conservation status of aquatic insects in southwestern Western Australia in 3 orders: the Odonata, Plecoptera and Trichoptera have been determined using 3 sources: (1) identification of larval specimens from a large number of samples collected throughout the south-west as part of AusRivAS; (2) data from the State Salinity Strategy biological study of the wheatbelt region; and (3) the collation of previously published records of occurrence for species within the south-west.

The high rainfall, forested region of the south-west was found to be important for a large number of species, including the majority of those found to be rare and/or restricted. A total of 37% of species were found to be threatened using IUCN criteria. The Trichoptera contained both the greatest number and highest proportion of threatened species. Two environmental parameters known to be affected by human disturbance in the south-west, salinity and nutrients, were found to be important in determining the occurrence of many species. These results indicated that increasing salinization and eutrophication will have a negative impact on the conservation of aquatic insects in the region. Results of this project have formed the basis for a number of recommendations for the conservation and management of aquatic insects in south-western Australia.

Publications to date
Sutcliffe, K., Taplin, R., Davis, J.A. and Halse, S.A. 2002. Factors affecting the distribution of stoneflies (Plecoptera) in south-western Australia. *Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie* 28 (in press).

Scientist: D Coates
Student: C Waters

Project title
Developing seed provenance zones for Australian native grasses.

Progress Report
The use of native grasses either as an understorey or grassland community is largely ignored in revegetation activities due to lack of available seed. Adequate supply of seed is an issue of great strategic importance if revegetation activities are to expand towards large-scale planting's. To increase availability of seed and ensure the adaptive and low input advantages of native grasses are retained we require an understanding the scales of ecotypic variation within a species, its adaptive consequence and the relevance of issues of local provenance. *Austrodanthonia caespitosa* will be used as a model system to investigate these issues.

This study commenced in April 2003, when 2 seminars (CSIRO, Canberra; NSW Agriculture, Trangie) were given outlining the study methodology in accordance to the CSU post-graduate scholarship requirements.

A total of 410 *Austrodanthonia caespitosa* plants have been collected from 23 sites though out central and western New South Wales. For each of these, whole plants have been transplanted into a parent nursery at the NSW Agricultural Research Centre, Trangie. This represents half the total material to be collected. Some seed has been collected from this material and further collections will be made in spring. Analysis of soil samples collected with each plant is on-going.

The literature review has commenced and a first draft should be submitted to the University by Aug 2003.

Scientist: D Coates
Student: C Gage

Project title
Genetic and ecological viability of fragmented populations of the long lived woody shrub *Eremaea*

pauciflora.

Progress Report
The aim of this research is to identify and quantify genetic and demographic processes that determine the viability of populations of the common myrtaceous shrub *Eremaea pauciflora* which occurs in the heavily fragmented landscape of the WA wheatbelt. This research will employ a range of techniques including the use of molecular genetic markers (isozymes and microsatellites), demographic monitoring and growth experiments to examine aspects of the genetics and ecology of remnant populations of *E. pauciflora*. This work will extend previous genetic and ecological research on factors affecting the viability of rare plant populations within remnant vegetation. Combined with studies on other common species, this is an important step in developing guidelines 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.

During 2002, 19 populations of *E. pauciflora* were chosen for sampling. Viable seed production was investigated and population genetic diversity studies were completed. Currently, viable seed production for 2003 is under investigation and microsatellite markers to assess geneflow are being developed. Germination and seedling fitness trials are planned to commence in Oct 2003 and Jan 2004 respectively.

Scientist: I Abbott
Student: T Simmons

Project title
The potential of birds as indicators of the recovery of Jarrah forest after any impact, minor or major (fire, logging, dieback, mining).

Progress Report
By conducting intensive bird and vegetation surveys, a model of bird communities after impacts and over time could be created. Using the created model, a series of bird surveys within an area could then be conducted, and from the presence and density of specific species, the type of impact and time since that impact could be established, and the time left before the site is fully recovered from the impact estimated.

After a full year of surveys a huge amount of data has been collected, and statistical analysis has been started. The results are quite interesting. By creating an MDS of the data based purely on the bird community composition, it can be seen that there is statistical separation between the different impacts and the years since the impacts. The amount of separation becomes smaller as time since impact increases, as suspected before the study was attempted. Due to the length of time and small number of sites assessed in the study, a new study is to be completed, which will allow a more thorough investigation of the patterns observed and identified previously, allowing the creation of a more robust model than is in the process of being completed at the moment.

Scientist: I Abbott
Student: M Williams

Project title
The effects of fire on day-flying Lepidoptera (butterflies, burnets and sun moths) at 4 sites on the Swan Coastal Plain.

Progress Report
Three distinct projects are being undertaken concurrently within the 4 sites: (i) a methodological study to determine optimum sampling strategies; (ii) mark-recapture studies of 2 rare butterfly species to examine population changes after fire; and (iii) regular surveys to quantify changes in abundance and richness of the day-flying Lepidoptera following fire.

During this year (fiscal 2002/03) the study was expanded from one to 4 sites, comprising Koondoola Regional Bushland Reserve, Warwick Open Space, Cottonwood Crescent Bushland and Kensington Bushland. 24 species of day-flying Lepidoptera (21 butterflies, 1 burnet and 2 sun-moths) have been

identified in the surveys, including the threatened Graceful Sun Moth *Synemon gratiosa*.

In the second year of the mark-recapture study of western jewels at Koondoola, 226 butterflies were marked in 5, 2-hr sessions during the main flight period. For most species it is not yet known whether successful breeding in the burnt area at Koondoola has been re-established. The extent of the recolonization of this burnt area will be assessed again in 2004 and over subsequent years.

Scientist: I Abbott
Student: B Giltay

Project title
The use of bioindicators (biological indicators) as a measure of soil health and quality.

Progress Report
The current study attempts to provide a preliminary measure of soil health and quality in the Wanneroo region. To achieve this, 3 land uses upon a common soil type (i.e. the Bassendean Sands) have been chosen to represent the dominant land use/soil type combination of the region. Remnant vegetation, low level grazing and a more intensive cropping system are 3 land-uses which frequently occupy the same plot of agricultural land in Wanneroo. The Bassendean Sands, being free draining and organic to a shallow depth ought to be inhabited by a select community of soil animals. Earthworms (macrofauna) and mesofauna, namely collembola and mites, will be investigated from the upper soil profile. Core samples will be taken to a depth of 20 cm from the soil surface and divided into 2 layers, corresponding to the depth at which macro and mesofauna reside. Extraction will be conducted on these samples to determine the abundance of organisms, whilst further experimentation using treatments will establish the factors affecting the activity of soil fauna.

Scientist: I Abbott
Student: T Graham

Project title
The abundance and diversity of insect fauna from Waychinicup National Park and Gull Rock reserve, and on assessment of any effects of aerial applications of phosphite on invertebrate communities.

Progress Report
This Honours project is part of a wider collaboration between scientists at DCLM and Murdoch University, and is a core project in the Murdoch/DCLM *Phytophthora* Research Centre.

Phosphite is the only chemical control for *Phytophthora cinnamomi*, and its continued use is subject to assessments of potential impacts on non-target organisms. Invertebrates were sampled from pre- and post-infestation areas at both sites to gauge:

1. Potential effects of *P. cinnamomi* infestation on invertebrate communities.
2. Potential effects of Phosphite application on invertebrate communities.

Pre-spray invertebrate samples were taken in March with follow-up sampling undertaken in May, while phosphite was applied to both sites in early April (12 g / ha). Invertebrates were sampled using transects of pitfall traps (10 in each) and timed bush beating methods. Pre-spray samples from Waychinicup have been sorted to Order and some of the common species from Hymenoptera, Collembola, Coleptera, Orthoptera and Blattodea. Species of orders Mantodea, Phasmatodea, Dermaptera and Hemiptera have also been found but in smaller numbers. The project will be completed in Nov 2003.

Scientist: T Friend
Student: J Whelan

Project title
To examine the effects of *Phytophthora cinnamomi* on the productivity of fungi and its impacts on mycophagous mammals in south coastal heaths.

Progress Report
The target species is the bush rat (*Rattus fuscipes*) with comparisons made to the critically endangered Gilbert's Potoroo (*Potorous gilbertii*). *P. cinnamomi* has the potential to eliminate susceptible plant species in an area which may form a symbiotic relationship with mycorrhizal fungi, thereby threatening the food resources consumed by these species.

The study sites are located in Waychinicup Nature Reserve and Waychinicup National Park, 65 km east of Albany, and comprise areas unaffected by *P. cinnamomi* and those previously infected by this pathogen. Initial trapping in these sites has been conducted using Elliott traps (1 200 trap-nights so-far) and preliminary fungal surveys have been carried out. The various components of the bush rat's diet will be examined, as currently no dietary studies on this mammal have been conducted in Western Australia. The identified fungal material will be compared to the fungi in the diet of the Gilbert's Potoroo, to determine if any resource overlap exists and if the fungal species consumed by this critically endangered mammal are potentially affected by *P. cinnamomi.* Differences in fungal productivity between pre- and post-*Phytophthora* infestation will also be assessed.

Scientist: P Van Heurck
Student: D Herath

Project title
236 Nuyts Beetles.

Progress Report
Beetles were collected in Dec 2002 and Feb 2003 with the help of volunteers from the Walpole-Nornalup National Parks Association. The study involves the sorting and analysis of beetles from pitfall traps at 9 sites with different fire ages and regimes. These sites ranged from Tingle forest unburnt since 1937 to Tingle, Karri, Jarrah and Marri forests burnt in the March 2001 wildfire in the Nuyts Wilderness. All these sites are located in old growth forest within the Walpole-Nornalup National Park.

The Dec 2002 samples are being sorted, and identification of some of the beetle morphospecies and also setting up a reference collection is proceeding. All sites have been visited with P Van Heurck and E Middleton in order to learn the survey design and trapping techniques for setting pitfall trap surveys. The plan for the future is to develop a plant species list, measure litter depths and map the common microhabitats at each of the sites.

Once the Dec 02 beetles have been sorted to morphospecies for each site, they will be analysed against the plants and microhabitats to indicate why they have been found at these sites in relation to the sites fire histories.

Scientist: M Byrne
Student: R Butcher

Project title
Systematics of the south-western Australian endemic genus *Synaphea* R.Br. (Proteaceae: Conospermineae).

Progress Report
Synaphea R.Br. is endemic to the South-West Botanical Province of WA and the genus comprises small shrubs characterized by tough, usually divided leaves and small, yellow, tubular flowers held in a spike. The differentiation of species is notoriously difficult as the taxa are distinguished by subtle size, curvature and pubescence characters. The number of named species in *Synaphea* has recently been increased, but the taxonomy is far from resolved. Taxonomic resolution of the genus is required for conservation and management, as many species are recorded as having highly restricted geographic ranges.

Morphological and molecular characters have been used in cladistic analyses to test the infrageneric classification of *Synaphea* proposed by A George in which the genus was divided into 4 sections. These analyses indicate that *S. pinnata* is highly distinctive in the genus and may warrant recognition at sub-

generic level, but that there is no support for recognizing the other sections proposed. These analyses also indicated that DNA sequence data from the Internal Transcribed Spacer region (nrDNA) and the *trn*L-*trn*F region (cpDNA), which are commonly used in molecular systematics, are not informative to differentiate between many morphologically divergent taxa in *Synaphea*.

Scientist: M Byrne
Student: N George

Project title
The development of Koojong (*Acacia saligna*) as a deep-rooted perennial crop species for southern Australia.

Progress Report
Acacia species have potential as short rotation tree crops for the medium to low rainfall areas of southern Australia because they can produce a range of products with commercial value. Knowledge of the genetic variation, fodder potential and reproductive biology of *A. saligna* will facilitate its development as a tree crop.

An extensive field survey of the naturally occurring populations of *A. saligna* has been carried out and thirty 5 study sites selected. From the field work a preliminary model of the morphological diversity and natural variation within the species has been developed. A survey of the genetic variation across the species range is being carried out with RFLP markers. Preliminary analysis of the genetic data suggests that there are 3 genetically distinct entities within *A. saligna*. Further analysis in conjunction with the morphological variation is being carried out to provide information to guide taxonomic implications. Investigation of aspects of the reproductive biology of *A. saligna*, such as pollinator observations, flowering phases, seed set, pollen storage and cross compatibility between entities, will commence this flowering season.

Scientist: M Byrne
Student: D Nicolle

Project title
Systematics of the southern Australian mallees, *Eucalyptus* series Subulatae (Myrtaceae).

Progress Report
Eucalyptus series Subulatae is a group of poorly known mallee and tree species distributed across the southern half of the Australian mainland, with greatest taxonomic diversity in the highly fragmented wheatbelt regions of Western Australia and South Australia. This study aimed to delimit taxa within the series and establish evolutionary relationships between the delimited taxa within the series, as well as assessing the relationship with other putatively closely related series. Both morphological and molecular methodology has been used to fulfill these aims. A better understanding of taxonomic limits and relationships will enable the conservation assessment and management of the taxa within the series, which includes some rare and poorly known taxa.

The results of the study indicate that 37 terminal taxa (25 species) can be identified in the series using seedling and adult morphological characteristics. Some of the taxa described recently (Johnson & Hill, 1999) cannot be identified and are considered synonymous with existing taxa, while other previously unrecognized taxa are also identified and described. Both morphological and molecular results indicate that cross-taxon gene flow has been an ongoing and important cause of the current biogeographical patterns seen in *E.* ser. Subulatae.

Scientist: M Byrne
Student: L Stone

Project title
Propagation of blue-flowered *Conospermum.*

Progress Report
Investigation of the breeding system of *Conospermum* is being carried out to provide information to assist in

the propagation of these plants. Experimental cross-pollination of field-grown plants resulted in 100% flower abortion, however the plants set seed naturally. Genetic analysis of the naturally set seeds collected from a single 'mother' plant, using RAPD analysis, revealed the seeds were largely selfed, with limited outcrossing in the field situation. In comparison genetic analysis of naturally set seed from a wild populations showed that the majority of the seeds were outcrossed.

Conospermum is being propagated through somatic embryogenesis. Genetic analysis of the plantlets was undertaken to determine if somoclonal variation occurred in somatic embryos and shoots derived from somatic embryos of *Conospermum*. DNA was extracted from discrete somatic embryos and juvenile green shoots that originated from embryos, and analysed using RAPDs. The somatic embryos originated from a single zygote, and had been in culture for up to 18 mths. Preliminary results suggest that some somoclonal variation is evident.

Scientist: M Byrne
Student: E Walker

Project title
Determining the hybrid status of *Eucalyptus bennettiae* and *Adenanthos cunninghamii.*

Progress Report
The declared rare flora species, *Eucalyptus bennettiae* and *Adenanthos cunninghamii*, are believed to be hybrid taxa. The genetic identify of these taxa and populations of their putative parental species were investigated.

Genetic analysis of the 2 populations of *E. bennettiae* showed that the multiple clumps had identical genotypes and there is only one individual at each site. The genetic identify of the *E. bennettiae* individuals at each site was not unique and represented a combination of the genetic diversity present in the 2 putative parental species *E. sporadica* and *E. lehmannii*. The genetic analysis confirmed the hybrid identity of *E. bennettiae*.

Genetic analysis of 2 populations of *A. cunninghamii* also showed that the species contained no unique genetic diversity and represented a combination of the genetic diversity present in the 2 putative parents, *A. sericeus* and *A. cuneatus*. Seedlings germinated from seed collected from a plant of *A. cunninghamii* was not morphologically identified as *A. cunninghamii* and showed segregation of morphological characters typical of hybrid progeny. The genetic analysis confirmed the hybrid identity of *A. cunninghamii.*

Eucalyptus bennettiae and *A. cunninghamii* do not meet the criteria for listing of hybrid taxa and have been recommended for removal from the Declared Rare Flora List.

Scientist: M Byrne
Student: C Tauss

Project title
Phylogeny, phylogeography and conservation of *Reedia spathacea* in south-western Australia.

Progress Report
Reedia spathacea is a monotypic genus that is restricted to wetland areas in the south-west of Western Australia. The systematic position of the genus within the Cyperaceae family is unknown and this study will use morphological data and molecular sequence of the Rbcl gene to clarify the systematic relationships of the genus. The species inhabits resilient wetlands where high water tables are maintained which may have been refugia during Pleistocene periods of aridity. Phylogeographic analysis of *R. spathacea* is being carried out to investigate the evolutionary history of the species.

Scientist: M Byrne and M Stukely
Student: M Wheeler

Project title

Reproductive biology and genetic diversity in *Eucalyptus marginata.*

Progress Report
Eucalyptus marginata (Jarrah) is a dominant forest tree in the south-west forests. Dieback resistant Jarrah lines have been developed and planted in seed orchards to provide a source of improved germplasm for use in rehabilitation of mine sites and disease affected sites. Utilization of germplasm is enhanced by a knowledge of the genetic diversity within the species. The level and structuring of genetic diversity within the nuclear genome was investigated using RFLP markers. In addition, the genetic relationships and degree of differentiation between the 3 morphologically recognized subspecies was assessed. A study of chloroplast DNA was also conducted to investigate the evolutionary history of the species.

Little genetic structuring was observed in the nuclear genome of *E. marginata*, although there was clear separation with its closest relative, *E. staeri.* The morphologically recognized subspecies were not differentiated from each other, and 2 outlier populations also showed no differentiation from populations in the main distribution. In contrast, the chloroplast DNA study identified separation between the coastal plain populations and those of the forest. Phylogeographic analysis suggests this fragmentation corresponds with the onset of the Pleistocene and the flooding of the Swan Coastal Plain.

Scientist: C Yates
Student: A Franks

Project title
Landscape fragmentation and rare plant species: Can we develop a general framework of population responses?

The aims of the project are:
- To categorize threatened plant taxa on the basis of functional attributes, and choose taxa for detailed investigation on the basis of their distribution across the landscape and potential to deliver quantitative data.
- To develop models for each floral architecture functional group on how rates of pollination, seed production, genetic diversity and seed fitness are affected by population size and landscape context.
- To extrapolate information from models for each floral architecture functional group to other taxa in that group to provide guidelines for flora conservation, including translocations, threatened ecological communities and restoration/revegetation programs.

Progress Report
Since the beginning of this project (June 2002) the following milestones have been achieved:
1. Formulation of traits to be assessed so as to classify the 351 declared rare flora into floral functional groupings.
2. Measurement and recording of the above traits and incorporation into a MS Access database.
3. Analysis of the above traits to produced multivariate cluster diagram based on various traits recorded.
4. Review of relevant literature pertaining to the project.
5. Presentation of project overview at the annual conference of the Ecological Society of Australia in Cairns (Nov 2002).
6. Brief overview of project description written for the Newsletter of the Australian Network for Plant Conservation (*Danthonia*).
7. Reconnaissance field trip to determine possible study sites and study species.

Journal Articles
Franks A.J., Yates C.J. & Hobbs R.J. (in prep.). Floral functional types: A general method of classifying rare plant population responses to habitat fragmentation. *Australian Journal of Botany*.
Franks A.J., Yates C.J. & Hobbs R.J. (2002). Sex outside the city: Habitat fragmentation and rare plants. *Danthonia* 11, 6-7.

Seminars
Franks A.J., Hobbs R.J. & Yates C.J. (2002). *Sex in a fragmented landscape: Developing a general*

framework of rare plant population responses to habitat fragmentation. Oral presentation delivered to Ecology 2002 Conference, Cairns Convention Centre, Cairns.

Scientist: R Robinson
Student: P Scott

Project title
To identify the causal organism of stem cankers upon the critically endangered *Eucalyptus phylacis*.

Progress Report
The *Eucalyptus phylacis* site was preliminarily surveyed with R Robinson and representatives from the Department of Conservation and Land Management (DCLM) on 2/2003. As stem tissue was required for canker fungi isolation an application to sample declared rare flora was submitted to the DCLM. The application required determining the least invasive sampling methodology. The permit was approved in 4/2003.

The site was then surveyed in greater detail on the 4/2003 with R Robinson and T Burgess and then on the 5/2003 with G Hardy. Preliminary ramet health and canker severity was scored. In accordance to permit regulations surface bark and stem tissue was sampled from cankered ramets. Significantly cankered *Corymbia calophylla*, found adjacent to the *E. phylacis* site were also surveyed and stem and bark associated with cankers were sampled.

Pure fungal cultures were isolated from stem and bark tissue grown in non-selective agar mediums and spore isolations from sporulating fruiting bodies. At present fungi are being identified through:
a) Reference to standard mycological keys and,
b) Use of molecular tools.

Preliminary data indicates a predominance of *Botryosphaeria* spp, *Cytospora* and *Endothiella* like fungi.

C. calophylla and *C. ficifolia* seedlings are being grown at Murdoch University for use in future pathogenicity trials.