ANNUAL RESEARCH ACTIVITY REPORT

July 2003 – June 2004

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 2003 / 2004. During this period, 21 staff were transferred from the Science Division to Natural Resources Branch (CALM) (12) and the Forest Products Commission (9).

Over this period staff produced more than 173 publications, were active on 159 research projects, assisted or supervised 68 mostly PhD students and developed some 77 significant partnerships with external agencies. In addition, they provided advice, gave presentations and assisted with numerous 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.

CALM Region	No. Projects
South West	48
Warren	48
Swan	42
South Coast	35
Wheatbelt	34
Midwest	29
Pilbara	19
Goldfields	19
Kimberley	11

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
61-70	Jarrah Forest
41-50	Warren
31-40	Avon Wheatbelt, Swan Coastal Plain
21-30	Esperance Plains, 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
5 July 2004

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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.

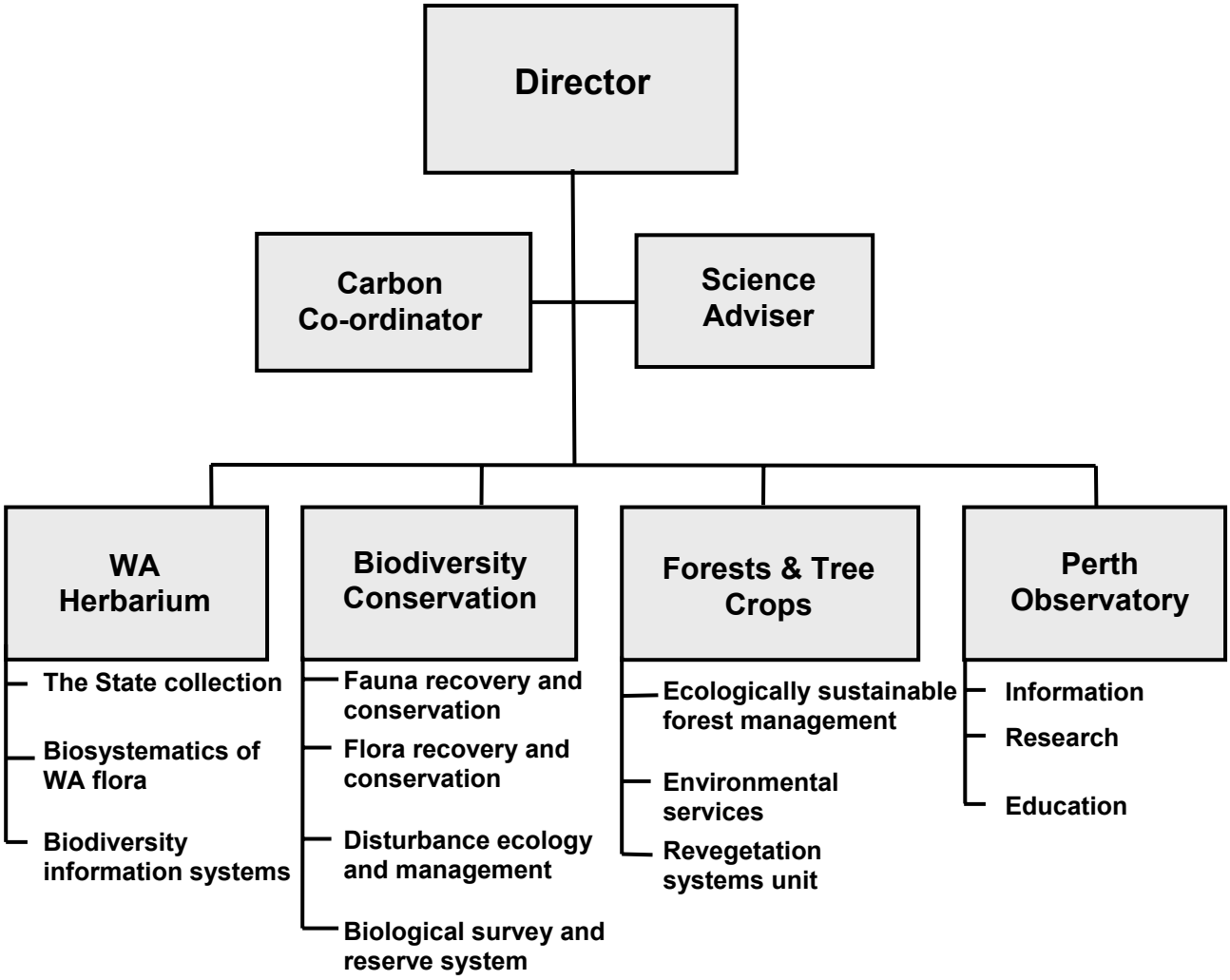
ROLE

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 the Department of Conservation and Land Management (CALM), and carrying out CALM's other legislative responsibilities.
- To ensure that Science Division is responsive to the needs of policy makers and output purchasers in CALM and the Forest Products Commission (FPC) by bringing science to bear on the solution of the State's most pressing problems relating to conservation and land management.
- To advise CALM 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 CALM 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 CALM, 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 139.

Biological component

CALM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Abbott, Ian	Tim Simmons	Establishing bird community indices in the Jarrah forest of southwest Western Australia	PhD	2001-04	Prof J Fox and Adj Prof S Davies	Curtin University
Abbott, Ian	Dean Paini	The impact of the European honey bee (*Apis mellifera*) on Australian native bees	PhD	1998-03	Prof W Bailey and Dr D Roberts	University of Western Australia
Abbott, Ian	Matt Williams	The effects of fire on day-flying Lepidoptera (butterflies, burnets and sun moths) at 4 sites on the Swan Coastal Plain	PhD	1999-08 (0.4 FTE)	Prof B Lamont	Curtin University
Abbott, Ian	Brian Giltay	The relationship between soil mesofauna and land use	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 Garkaklis	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 Garkaklis	Murdoch University
Burbidge, Allan	Liz Fox	Individual call recognition in birds	PhD	2004-07	Dr D Roberts	University of Western Australia
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	2002-05	Dr G Yan	University of Western Australia

CALM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Byrne, Margaret	Dean Nicolle	Taxonomic revision of *Eucalyptus* series *Subulatae*	PhD	1998-04	Dr M Whalen	Flinders University
Byrne, Margaret	Ryonen Butcher	Systematics of the south-western Australian endemic genus *Synaphea* R.Br. (Proteaceae: Conospermineae)	PhD	1997-05	Dr J Chappill	University of Western Australia
Byrne, Margaret	Cate Tauss	Phylogeny, phylogeography and conservation of *Reedia spathacea* in south-western Australia	MSc	2002-06	Dr J Chappill	University of Western Australia
Byrne, Margaret	Lynley Stone	Propagation of blue-flowered *Conospermum*	PhD	2000-03	Prof J McComb	Murdoch University
Byrne, Margaret	Melissa Millar	An assessment of genetic risk to natural biodiversity from agroforestry revegetation	PhD	2004-07	Dr I Nuberg	University of Adelaide
Byrne, Margaret	Kirsten Muir	Flora biology and mating system in native sandalwood, *Santalum spicatum*	Honours	2004	Dr C Cox	Curtin University
Byrne, Margaret	Rina Hendrati	Development of *Eucalyptus occidentalis* for revegetation	PhD	2004-08	Dr J Plummer	University of Western Australia
Byrne, Margaret	Eletheria Dalmaris	Physiology of Wandoo decline (ARC project)	PhD	2003-06	Prof H Lambers and Dr E Veneklaas	University of Western Australia
Chapman, Alex	Amanda Spooner	Systematics and Conservation of Lambertia Sm. (Proteaceae)	MSc		Dr K Lemson	Edith Cowan University
Coates, Dave	Christopher Gage	Genetic and ecological viability of fragmented populations of the long lived woody shrub *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	Ian Bertram	Translocation outcomes for the western ringtail possum, *Pseudocheirus occidentalis.* Interim survivorship analysis of populations in 1080 baited and unabated translocation release sites	MSc	2004-05		University of Glasgow, Scotland
Friend, Tony	Jeremy Lee	Haemoparasites and ectoparasites of Gilbert's Potoroo	Honours	2004	Dr P Irwin	Murdoch University
Friend, Tony	Steve Smith	Adding DNA to the Toolbox: using conservation genetic techniques to assist with the recovery of 5 threatened marsupial species from Western Australia	Ph.D.	2003-06	Dr J Hughes	Griffith University
Friend, Tony	Annabelle Stewart	Competitive interactions between island populations of dibblers (*Parantechinus apicalis*), Boullanger Island dunnarts (*Sminthopsis griseoventer boullangerensis*) and house mice (*Mus domesticus*).	Ph.D.	2002-05	Dr R Bencini	UWA

CALM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Halse, Stuart	Winston Kay	Population ecology of estuarine crocodiles, *Crocodylus porosus*, in the Kimberley region of Western Australia	PhD	2000-04	Prof G Grigg and A/Prof H McCallum	University of Queensland
Halse, Stuart	Erin Lowe	Macroinvertebrates and diatoms as indicators of acidity in wetlands of Western Australia	PhD	2000-04	A/Prof J John	Curtin University
Halse, Stuart	Chris Gouramanis	Ostracods as indicators of lake conditions and fine–scale climate change in southern Australia	PhD	2003-06	Prof P De Deckker	Australian National University
Halse, Stuart	Jean-Michel Benier	An investigation of the importance of farm dams in the wheatbelt of Western Australia for the conservation of aquatic macroinvertebrates	MSc	1997-04	A/Prof P Horwitz	Edith Cowan University
Macfarlane, Terry	Kelly Shepherd	Taxonomic and evolutionary study of the samphires (Chenopodiaceae subfamily Salicornioideae	PhD		Dr T Colmer	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
McCaw, Lachie	Robert Archibald	The role of fire in the decline of tuart (*Eucalyptus gomphocephala*) woodlands	PhD	2003-06	Dr G Hardy and Dr B Bowen	Murdoch University
Morris, Keith	Damien Cancilla	Ecology of the heath mouse *Pseudomys shortridgei*	PhD	2003-05	Dr G Hardy	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, David	Zoe Hamilton	Marooned Lizards: Variation in isolated and fragmented populations of *Egernia stokesii*	Hons	2003	Dr M Johnson, Dr J O'Shea and Prof D Bradshaw	University of Western Australia
Pearson, David	Peter Langlands	Spiders, spinifex, rainfall and fire: Responses of spiders to burning and rainfall in the Great Victoria Desert, Western Australia	Hons	2003	Dr K Brennan	Curtin University
Pearson, David	Leah Delfs	Lizards of the *Tiliqua* genus in the urban environment	PhD	2003-6	Dr M Pennachio, Dr D Groth and Dr J Wetherall	Murdoch University
Pearson, David	Leisa Turner		Hons	2004	Dr A Needham	Edith Cowan
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
Pearson, Grant	Danny Rogers	Conservation and Ecology of Migratory Shorebirds in Roebuck Bay	PhD	2002-04	Dr T Piersma	Charles Sturt University

CALM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Pearson, Grant	No student project	The role of stable isotopes in food webs in Roebuck Bay and Eighty-mile Beach			Dr A Storey and 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
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 and 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		Prof 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
Shearer, Bryan	P Scott	Tuart decline	PhD	2004-07	Dr G Hardy	Murdoch University
Shearer, Bryan	R Hooper	Wandoo decline	PhD	2004-07	Prof K Sivasithamparam	University of Western Australia
Shearer, Bryan	J Ellery	*Ramularia* leaf infection	Honours		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 and Byrne, M	Margaret Wheeler	Reproductive biology and genetics diversity in *Eucalyptus marginata*	PhD	2000-03	Prof J McComb	Murdoch University
Van Heurck, Paul	Dulana Herath	The impact of fire on the beetle forest floor communities in Walpole-Nornalup National Park	Honours	2002-04	Prof J Majer	Curtin University

CALM Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Van Leeuwen, Stephen	Gerald Page	Christmas Tree Mulga in the Pilbara – Calcium Nutrition and Community Health	Honours	2004	Dr P Grierson	University of Western Australia
Yates, Colin	Andrew Franks	Landscape fragmentation and rare plant species: Can we develop a general framework of population responses?	PhD	2002-05	Prof R Hobbs	Murdoch University
Yates, Colin	Kellie Maher	Fire, fragmentation and mammals, synergistic impacts on ecosystem dynamics	PhD	2004-07	Prof R Hobbs	Murdoch University
Yates, Colin	Carrie Buscomb	Ecological consequences of habitat fragmentation in *Banksia sphaerocarpa* ssp. *sphaerocarpa*	Hons	2004	Prof R Hobbs	Murdoch University

Astronomical component

Biggs, James	Shane Walsh	Astronomical Seeing	Honours project	2003-04	Prof M Zadnik	Curtin University
Biggs, James	Katherine Reynolds	Photometry of SS2883	3rd Yr research project	2004	Prof M Zadnik	Curtin University
Biggs, James	Christopher Daly	An evaluation of solar power for remote telescopes	3rd Yr research project	2004	Prof M Zadnik	Curtin University

EXTERNAL PARTNERSHIPS

Biological component

Partnership Name	**Project - i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Involvement ($)**	**Involvement (in kind)**
ABRS	Taxonomy of Stylidium: 1 Scientist	$72k for 3 yrs	Curatorial (0.05)
ABRS	Taxonomy of Baeckea: 1 Scientist	$36k for 3 yrs	B Rye (0.5), Curatorial (0.05)
ABRS	Taxonomy of Asteraceae: 1 Scientist	$20k	Curatorial (0.05)
Alcoa	Diversity in Dieback Resistant Jarrah (DRJ) clones	$13k	M Byrne (0.1)
ANU	Pilbara biological survey groundwater mapping, ostracod identification and shell chemistry as habitat indicator, Prof P De Deckker, Dr J Reeves	CALM contribution $50k	S Halse (0.05)
ANZEC / CRC for Australian Weed Management	Technical Group for weeds of conservation significance	Nil	G Keighery (0.05)
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 pa. Other collaborators include National Research Centre for Environmental Toxicology and University of Melbourne.
Bushfires CRC	Managing fires in forest landscapes SW Australia	$40k pa over 7 yrs 2003-10 contributed by CALM. $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 pa)
Chevron-Texaco	Monitoring mammals on Barrow Island	$6k pa 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 for Greenhouse Accounting	Project A2 Developing carbon accounting systems		R McKellar (0.1), 1.3 FTE
CRC for Plant Based Management of Dryland Salinity	Biodiversity Program Project - Management of weed and genetic risk in perennial landuse systems	$756 200 over 4 yrs (2004-2008)	M Byrne, M Lyons, S Halse, N Gibson
Dampier Salt	Pilbara biological survey	20 airfares Perth – Karratha - Return	S van Leeuwen
Dept of Environment (Cwth)	AVH: Australia's Virtual Herbarium: 2 databasers, curator	$96k for 5 yrs	A Chapman (0.05), Database (3.0)
Dept of Industry and Resources – Pilbara Iron Environment Committee	Pilbara biological bibliographical database	$6k for 2004 ($4k committed for 2005)	S van Leeuwen (0.01), Paul Gioia (0.01)
Dept of Planning & Infrastructure	SWALE: Surveying WA's Land Edge: 1 Scientist	$20k for 2 yrs	N Lander (0.05), R Davis (0.05),
Dept of Planning & Infrastructure	MPP: Marine Plants Project: 1 curator	$24,750 plus 2004/2005	C Parker (0.2), Database (1.0)
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 (in kind)**
Dept of Primary Industries Victoria	PAPP toxicosis	To be advised	D Algar (0.02), K Morris (0.02)
Dept of Agriculture WA	GIS vegetation mapping	2002-03 - $20k 2003-04 - $10k	G Serendenco (0.3)
Desert Knowledge CRC	2 Scientists	No $ contribution	M Cowan (0.25), A Hopkins (0.5), K Tinley (1.0) + 1 more to be advised
Hamersley Iron	Pilbara biological survey – subsidized rental of accommodation unit in Karratha	$690 month subsidized	S van Leeuwen
Land and Water Australia / CSIRO	Genetic & ecological viability of plant populations in remnant vegetation. (PhD scholarship)	$92k total ($67k LWA, $25k SAP) $7k CALM contribution	D Coates (0.4), M Byrne (0.1), C Yates (0.2), C Elliott (1.0), B MacDonald (0.1)
Lotteries West	Insect databasing - CALM's insect collection: 1 databaser	$7,431 final funding	Database (0.05)
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 bandicoot, Gilbert's Potoroo, Quenda – ARC Linkage Grant	$15k pa for 3 yrs	T Friend (0.05)
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), and $7 500 yr for 2002-4 CALM 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	PhD student Kellie Maher LWA Stipend - Fire, fragmentation and mammals, synergistic impacts on ecosystem dynamics	$30k pa for 3 yrs	C Yates (0.2)
Murdoch University	Epidemiology of Marri canker	Nil	B Shearer (0.4)
Murdoch University	The extraction of DNA from reptile scales and sloughed skins	Nil	D Pearson (0.05)
Murdoch University, Edith Cowan University, Alcoa, City of Mandurah	Tuart woodland decline (ARC project) including support for a PhD student	$280k over 3 yrs from ARC $195k over 3 yrs from Industry $20k per yr- CALM contribution	D Haswell (0.05), L McCaw (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 (CALM contribution)
Tropical Savannas CRC	Kimberley mammals	$55k for 2002-03 $55k for 2002-04 CALM contributes $10k pa into CRC - Sally Black's contract was paid for by CALM	T Start (0.8), N McKenzie (0.1), J Rolfe (0.1), S Black (0.25), A Burbidge (0.1)

Partnership Name	**Project - i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Involvement ($)**	**Involvement (in kind)**
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 (CALM)	G Pearson (0.05)
Newmont Australia and Gindalbie Gold NL	Genetic structure in the Priority One Species Genus sp. Yalgoo (JM Ward s.n. 11/7/1999)	$26k	D Coates (0.05), M Byrne (0.05), B Macdonald (0.05)
NHT	Western bristlebird research plan	$99 387	AH Burbidge (0.1), J Rolfe (0.05)
NHT	Western ground parrot recovery	$150k	AH Burbidge (0.1), B Barrett (1.0)
NHT	Pilbara biological survey, especially stygofauna	$273k	S Halse (0.8)
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 Information Sheets for WA	$6900	S Elscot (0.2), J Lane (0.05)
NHT	Nomination and improved documentation of nationally important wetlands in under-represented IBRA regions in WA	$70k for 2003-05	S Elscot (0.25), G Pearson (0.1), A Clarke (0.2), J Lane (0.15)
NHT2	Dibbler recovery program	$40 500	T Friend (0.1)
NHT2	Gilbert's potoroo recovery program	$73k	T Friend (0.75)
Nickol Bay Naturalists' Club (funded by Woodside)	Botanical survey of selected Dampier Archipelago islands	$5k	S van Leeuwen (0.2)
Nickol Bay Naturalists' Club (WWF/NHT funded)	Conserving Pilbara olive pythons on the Burrup Peninsula	$ 2k (CALM); $ 3k (TSN)	D Pearson (0.1)
PEST Animal Control CRC	Honours project: Fox re-invasion rates	Nil	N Marlow (0.05)
Portman Iron Ore and Botanical Gardens and Parks Authority	An integrated research program focused on practical outcomes for the *in-situ* and *ex-situ* conservation, restoration and translocation of the DRF *Tetratheca paynterae* (Tremandaceae)	$101k pa for 2004, 2005 and 2006	C Yates (0.4) D Coates (0.05)
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 finalization of project until end 2003	L McCaw (0.1), R Smith, J Neal
Robe River Iron Associates (West Angelas Coondewanna West Envion Offsets)	Botanical survey of Tussock Grassland communities in the Pilbara biogeographical region	$20k for 2003	S van Leeuwen (0.2), B Bromilow (0.2)
Robe River Iron Associates (West Angelas Coondewanna West Environmental Offsets)	Fire-Mulga study: post burn monitoring	$20k pa 2002-05 $103k 2006-2011	S van Leeuwen (0.1), T Start (0.05), B Bromilow (0.1)

Partnership Name	Project - i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Involvement ($)	Involvement (in kind)
Robe River Iron Associates (West Angelas Coondewanna West Environmental Offsets)	Wattles of the Pilbara	$68k for 2003	B Maslin (0.6), S van Leeuwen (0.1), B Bromilow (0.05)
Robe River Iron Associates (West Angelas Coondewanna West environmental Offsets)	A program to research and develop an integrated herbicide control regime of Ruby Dock (*Acetosa vesicaria*) in the Pilbara	$47250 for 2003	S van Leeuwen (0.05, collaboratively with Botanic Gardens and Parks Authority (B Dixon and J Anthony)
University of Adelaide	Pilbara biological survey/Wetland monitoring program – rotifer and cladoceran identifications, Dr R Shiel	$20k	S Halse (0.05) / A Pinder (0.05)
University of Northern Arizona	Pilbara biological survey diatom identifications, Prof D Blinn	CALM contribution $15k	S Halse (0.05) / A Pinder (0.05)
University of Western Australia	Physiology of Wandoo decline (ARC project) including support for a post doctorate position	$87 800 pa - ARC funds $25k pa - CALM contribution	L McCaw (0.1)
Urban Bushland Council, WA Naturalists Club, Lotteries West	PUBF: Perth Urban Bushland Fungi project: 1 Scientist, 1 Education Officer	$95k plus $226k 2004/2005	N Marchant (0.05), B Crane (0.05)
University of Western Australia	PhD – F Donaldson Social structure of burrowing bettongs	$5k pa for 2003-05 from Stipend funds (CALM)	K Morris (0.05) and equipment
University of Western Australia	Mode of action of phosphonate in native hosts to *Phytophthora cinnamomi* - PhD student – B Komorek	Nil	B Shearer (0.04)
University of Western Australia	Processes in lateritic soil in Western Australia - PhD student - A Koning	Nil	B Shearer (0.04)
University of Western Australia	Pilbara biological survey – amphiod genetics and taxonomy, Dr T Finston	Nil	S Halse (0.05), S Eberhard (0.05)
Walpole - Nornalup National Parks Association and Walpole Wilderness Eco-Cruises	The impact of wildfire on invertebrate communities in old growth forests	$45k for 2004-05	P Van Heurck (0.4), I Abbott (0.1), T Middleton (0.1), WNNPA volunteers (10 x 0.2 =2.0)
Western Australia Museum	Biogeography of insular populations in the Abrolhos	$ 5k (Mid West Region)	D Pearson (0.05)
Western Mining	Mulgaras and associated rare dasyurids of the North-Eastern Goldfields	$30k pa for 3 yrs finishes 2004	D Pearson (0.3)

Astronomical component

Partnership Name	**Project -** i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	**Involvement ($)**	**Involvement (in kind)**
Kent State University, USA; University of Cincinnati, USA, Edith Cowan University and Curtin University	ASTRONET - Perth Observatory education and information core functions	$2k	0.05 FTE Scientist, 0.1 FTE TO
University of California, Berkeley	Hands on Universe	-	0.05 FTE Scientist
Curtin University and University of Western Australia	Lecturing - Perth Observatory education core function	-	0.2 FTE scientist
Curtin 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 function	-	0.01 FTE TO
Fire Protection Services, CALM	Fire monitoring - Perth Observatory information core function	-	-
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
Scitech Planetarium	Astronomy education	-	0.05 scientist
IAU Minor Planet Center, 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.

STRATEGIC PLANNING STATEMENT for 2004/05 ALIGNED WITH CALM's KEY RESULT AREAS

Division: Science Division
Submitted by: Dr Neil Burrows

Summary of major / significant outcomes anticipated to be achieved in 2003/04 (indicated by Key Result Area):

Key Result Area	Anticipated outcomes or achievements
KRA 1. Establishment of a comprehensive, adequate and representative (CAR) terrestrial and marine conservation reserve system	Analysis, publication and dissemination of information of Wheatbelt Region biological survey and elucidation of salinity as a threatening process.
	Pilbara Bioregion biological survey - installation and partial assessment of terrestrial and aquatic sample sites.
	A range of sub-regional biological surveys – see below.
	Herbarium information systems continue to provide extensive support for systematic biological inventory. Herbarium records total 570,000 specimens and provide baseline information for assessment of comprehensiveness, adequacy and representativeness of the reserve system.
KRA 2. Maintenance of a terrestrial / marine protected area network (IUCN management categories I to VI)	New and ongoing field programs for developing fire management guidelines for selected threatened and fire sensitive taxa, e.g. quokka.
	Analysis and write-up of sub-regional biological surveys including; floristic survey of Warren botanical district, floristic survey of Goldfields Region, biological survey of Barlee Range Nature Reserve, floristic survey of Hamersley Range uplands, floristic survey of Hamersley Ranges tussock grasslands, biological survey of the south-western Little Sandy Desert, biological survey of Yanchep National Park, biological survey of Cape Arid National Park, floristic survey of remnants on Swan Coastal Plain, biological survey of Burrup Peninsula, floristic survey of the Darling Scarp.
	Ongoing monitoring and reporting; forest vertebrates, benthic invertebrate communities, mammals on Barrow Island, wheatbelt wetlands, Vasse-Wonnerup wetlands, Peel-Harvey estuary waterbirds, rare arid zone dasyurids.
	Herbarium Identification facilities service CALM operations and NC staff and CALM consultants undertaking surveys of conservation reserves and forests; survey of conservation taxa completed in southern forests.
KRA 3. Conservation of landscape / seascape scale ecological systems and processes (integrating reserve and off-reserve conservation)	Ongoing field work, data analysis and write up associated with a range of short and long term fire ecology projects in forest, woodland and desert ecosystems.
	New fire and biodiversity program – Bushfires CRC.

Key Result Area	Anticipated outcomes or achievements
	Fire regime interim guidelines for conservation of biodiversity in Warren and Jarrah Forest bioregions.
	Data analysis of the behaviour of high intensity jarrah forest fires.
	Data analysis of some ecological effects and behaviour of fires in hummock grasslands.
	Implementation and evaluation of a large-scale operational baiting trial to control feral cats, foxes and wild dogs in the arid zone rangelands.
	Ongoing fox and feral cat bait development and registration.
	Ongoing establishment and assessment of FORESTCHECK forest biodiversity monitoring sites.
	Ongoing investigations into the effective use of phosphite to control the impacts of *Phytophthora cinnamomi*.
	Determination of the susceptibility of a range of threatened flora to *Phytophthora cinnamomi*.
	Monitoring of the hydrological impacts of timber harvesting in the intermediate rainfall zone.
	Additional sampling to assess the emissions of dioxins from bushfires.
	Modelling the impacts of climate change on biodiversity.
	WWF Woodland Watch Project provides education and support for conservation of private lands; identification of key species for development of management of Biosphere reserves and world heritage properties; outstanding contribution has been made to community-based coastal ecosystems survey (SWALE Project); plant surveys of Lorna Glen, Buntine Marchagee projects etc.
KRA 4. Recovery of threatened species and ecological communities and conservation and sustainable use of other significant species	Ongoing monitoring of mammal translocations associated with Return to Dryandra.
	Possible new and additional translocations – Return to Dryandra - marl, mala, mernine, boodies.
	Complete field work and report on status of CWR mammals in the Kimberley.
	Implementation of recovery plans and ongoing field assessment, analysis and write-up of research into threatened fauna species including Gilbert's potoroo, brush-tailed phascogale, red-tailed phascogale, marine turtles, chuditch, quokka, western bristlebird, ground parrot, western ringtail possum, numbat, carpet and woma and Pilbara olive pythons, Lancelin Island skink, banded stilt, western barred bandicoot, western desert rock wallaby, dibbler, heath mouse.
	Commence reassessment of conservation status of WA Acacias.
	Provision of genetic information for determining the taxonomic status of flora, especially threatened flora.
	Ongoing collection, testing and storage of seed of threatened flora.
	Ongoing assessment of the conservation status of rare and poorly known flora thought to be critically endangered (130 taxa).
	Publication of wildlife management program for rare and poorly known flora – Goldfields Region.

Key Result Area	Anticipated outcomes or achievements
	Ongoing experimental translocations of critically endangered flora.
	Ongoing investigations into the genetic and ecological viability of plant populations in remnant vegetation.
	Identification of weed and native species in threatened ecological communities.
KRA 5. Providing for sustainable nature-based recreation and tourism and increased enjoyment and appreciation of protected areas	Provision of plant names to support information booklets (e.g. Bushbooks), nature trail signage and information brochures . Achievement highlights are publication of forest region flora handbooks, Forest Wheel Project; Ravensthorpe nature Trail etc. There are significant achievements in herbarium training of Operations, P & VS and NC Division staff on how to access plant information through FloraBase.
KRA 6. Providing community involvement and encouraging understanding, and support of biodiversity conservation and other Departmental programs and activities	Development of biodiversity information management systems (Naturebank).
	Landscope expeditions throughout WA.
	Landscope articles.
	Estimated 200 scientific publications from the Science Division.
	Numerous public meetings, scientific workshops, seminars, field days, etc.
	Numerous volunteers participate in the range of research projects outlined here.
	World Wide Wattle project and establishment of interpretive centre – Shire of Dalwallinu.
	Regional Herbaria and Weed Information Network projects; CALM staff and community plant collecting and plant information programs; 5 training sessions held in period; Science Teachers Associations presentation; The Herbarium successfully manages 60 internal and over 300 external volunteers.
	Regional or Divisional priorities and anticipated outcomes or achievements over two to three years
KRA 1. Establishment of a comprehensive, adequate and representative (CAR) terrestrial and marine conservation reserve system	Completion of field component - Pilbara biological survey – commence analysis and write-up.
	Recommendations for strategic acquisition of land for a CAR reserve system.
	Commence biological survey of priority forest areas (Forest Management Plan).
	All WA holdings of marine plant specimens are being databased through external grants in collaboration with Marine Branch. This will increasingly underpin marine management processes. The herbarium will continue to support systematic terrestrial biological survey and has developed an invaluable voucher specimen based support and feedback system that would assist ongoing surveys. This vouchering and information retrieval system needs to be better integrated in CALM so that flora and ecosystem data is added incrementally to state knowledge and not wasted.

Key Result Area	Anticipated outcomes or achievements
KRA 2. Maintenance of a terrestrial / marine protected area network (IUCN management categories I to VI)	The Herbarium will continue to provide plant identification and species information support for development of effective management of pastoral lands, State forests and timber reserves.
	Complete analysis and write-up of sub-regional biological surveys – see above.
	Adaptive management protocols for selected threatened and fire sensitive taxa, e.g. quokka.
	Ongoing monitoring and reporting; forest vertebrates, benthic invertebrate communities, mammals on Barrow Island, wheatbelt wetlands, Vasse-Wonnerup wetlands, Peel-Harvey estuary waterbirds, rare arid zone dasyurids.
KRA 3. Conservation of landscape / seascape scale ecological systems and processes (integrating reserve and off-reserve conservation)	Guidelines for the appropriate management of viable vegetation remnants in degraded and fragmented landscapes.
	Towards amelioration and control of threatening processes such as weeds and *Phytophthora* root rot.
	Ranking of the ecological importance of disturbances, including salinization, fire, flooding and grazing, for maintenance of biodiversity.
	Commencement of a comprehensive study into the impacts of frequent and extensive late season fires on biodiversity in the Kimberley.
	Commencement of landscape scale rehabilitation/restoration ecology research including focal areas of the wheatbelt.
	Commence program to assess the effectiveness of stream buffers – south-west forests (Forest Management Plan).
	Establishment of sites to monitor the impacts of climate change on biodiversity.
	Ongoing field work, data analysis and write up associated with a range of short and long term fire ecology projects in forest, woodland and desert ecosystems.
	Ongoing field work – fire and biodiversity program – Bushfires CRC.
	Ongoing assessment of mosaic burning trials, Walpole Wilderness Area.
	Fire management guidelines for conservation of biodiversity in Warren and Jarrah Forest bioregions.
	A model for predicting the behaviour of high intensity jarrah forest fires.
	A model for implementing a patch-burn mosaic in hummock grasslands.
	Large-scale operational baiting trial to control feral cats, foxes and wild dogs in the arid zone rangelands.
	Registration of new fox and cat baits.
	Five year review of FORESTCHECK. Ongoing establishment and assessment of FORESTCHECK monitoring sites.
	Strategies for the effective use of phosphite to control the impacts of *Phytophthora cinnamomi*.
	Ongoing trials to determine the susceptibility of a range of threatened flora to *Phytophthora cinnamomi.*

Key Result Area	Anticipated outcomes or achievements
	Modelling the hydrological impacts of timber harvesting in the intermediate rainfall zone.
	Herbarium Corporate information systems and in particular the Regional Herbaria and adjunct Weed Information Network can assist in community based natural resource management planning processes, especially by providing technical data and advice.
KRA 4. Recovery of threatened species and ecological communities and conservation and sustainable use of other significant species	Ongoing monitoring of new mammal translocations associated with Western Shield including translocations into the rangelands arid zone (Western Shield extension).
	Monitoring of CWR mammals in the Kimberley.
	Ongoing implementation of recovery plans and ongoing field assessment, analysis and write-up of research into threatened fauna species including Gilbert's potoroo, brush-tailed phascogale, red-tailed phascogale, marine turtles, chuditch, quokka, western bristlebird, ground parrot, western ringtail possum, numbat, carpet and woma and Pilbara olive pythons, Lancelin Island skink, banded stilt, western barred bandicoot, western desert rock wallaby, dibbler, heath mouse.
	Report on conservation status of WA Acacias.
	Ongoing provision of genetic information for determining the taxonomic status of flora, especially threatened flora.
	Ongoing collection, testing and storage of seed of threatened flora.
	Ongoing assessment of the conservation status of rare and poorly known flora thought to be critically endangered taxa.
	Ongoing experimental translocations of critically endangered flora.
	Ongoing investigations into the genetic and ecological viability of plant populations in remnant vegetation.
	Corporate information systems provide extensive data for nature-based recreation and tourism. FloraBase is increasingly used by CALM staff to access user-friendly plant information.
KRA 5. Providing for sustainable nature-based recreation and tourism and increased enjoyment and appreciation of protected areas	The Herbarium is expected to receive specimens collected under Scientific Licence Condition 7.1) This rarely happens and there are no funds to support processing. Appeals will continue to be made to review the Licence condition or provide support for processing specimens that add knowledge.
KRA 6. Providing community involvement and encouraging understanding, and support of biodiversity conservation and other Departmental programs and activities	Ongoing development of biodiversity information management systems (Naturebank).
	Landscope expeditions throughout WA.
	Landscope articles.
	Estimated 200 scientific publications from the Science Division.
	Numerous public meetings, scientific workshops, seminars, field days, etc.
	Numerous volunteers participate in the range of research projects outlined here.
	External funds have been received to enhance the Regional Herbaria network in the Northern Agricultural region. This will have an accent on weeds and documentation of threatened ecosystems as well as strong

Key Result Area	Anticipated outcomes or achievements
	support to the Marchagee-Buntine biological survey.
Community and local political pressures:	Community support for the Regional Herbaria Project is still very high. The Project was intended to be financially self -supporting after the initial grant expired however this was difficult to implement because of an expectation that the herbarium should provide an identification service to consultants etc. (it does to CALM staff). In 2003/2004 some well organised community groups have gained funds that will cover costs of specimen identification and processing.
Summary of any major staffing issues:	Main issue for the Science Division is ageing workforce. A Workforce Planning Strategy has been developed to address this. Implementation of this strategy will be a priority for the Division.
	Greater emphasis on networking and building partnerships.
	The Division is also in the process of restructuring.
	Division will focus more attention on 'regionalising research' through greater emphasis on consultation, advice, tech. transfer and participation in adaptive management programs in collaboration with Regions.
	Funding is required for an additional taxonomist.
Significant funding or other issues (i.e. summary of any issues you wish to raise relating to your cost centre budget and the delivery of Corporate and Output priorities)**:**	Ongoing problem of fixed costs: operating budget ratio. Ongoing salary for Anne Cochrane. Increased difficulties accessing external funds.
	Accommodation and space issues – Perth Herbarium.
	Placement of Perth Observatory.
	Funding is required for identification botanist - currently only 50% funded.
	Funding is required for Regional Herbaria coordinator and curator.
	Funding is required for Database Validator.
	Research Assistants are required for Taxonomist botanists (currently they do not have access to any research assistants unlike all other scientists in the Division).
	Curation FTE needs to be increased (currently only funded to 1.2 FTE).
	A thorough and comprehensive review of the Herbarium including management, planning, taxonomic output, staffing levels, funding, specimen preservation, health and safety issues and potential value of the Herbarium information systems to conservation is urgently needed.

RESEARCH ACTIVITY

WESTERN AUSTRALIAN HERBARIUM

Group Manager: Dr Neville Marchant

COLLECTIONS MANAGEMENT

Core Function

Team members

C S Fang (0.8), N Marchant (0.1), A Chapman (0.1), R Cranfield (0.1), K Knight (0.7), C Parker (0.5), P Spencer (0.5), S Carroll (0.5), K Veryard (1.0), M Falconer (1.0), BS Mahon (0.1), R Davis (0.75) D Pistol (1.0); Total (7.15).

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 and main findings

- 29 819 specimens were added to the collection, which now stands at 591 676.
- The major plant groups now in the collection are as follows:

Myxomycete	258
Fungi	9 461
Algae	9 686
Mosses	5 970
Liverworts	1 607
Lichens	8 563
Ferns	3 124
Gymnosperms	1 777
Monocots	92 815
Dicots	458 584
Total	**591 676**

- Significant curatorial work accomplished in the genera *Gastrolobium, Hibiscus, Oligochaetochilus, Caladenia, Drakonorchis, Cyanicula, Rubus Senecia, Olearia, Eucalyptus*.
- Validating currency of specimen names of the marine algal collection in preparation for census publication progressed.
- Significant collections added to the Herbarium holdings were as follows:
  - SWALE (Surveying Western Australia's Land Edge) Project.
  - Woodland Watch (World Wildlife Fund) of remnant vegetation in the wheatbelt.
  - Priority taxa for Swan Region by F Hort.
  - Salinity Action Project vouchers.
  - Specimens from survey of Jaurdi Reserve, Coolgardie by L Sage.
  - Gold for Survey (specimens from ground proofing of woodland/forest areas to validate remote sensing of vegetation from Esperance to Shark Bay, National Forest Inventory.

- Vouchers from System 6 survey, 1994/95.
- Hunger & Kilian Pilbara vouchers, 1995.
- Eleanor Bennett vouchers from the Ord River, 1999.
- Don Cooper SEARCH vouchers.
- Juliet Wege *Stylidium* specimens.
- Neville Marchant collection.
- M Trudgen vouchers from Mount Lawley Project.
- M Trudgen and B Rye vouchers of small flowered Myrtaceae.
- M Trudgen vouchers from Ellenbrook.
- M Trudgen Robe River vouchers.
- A Cochrane and A Crawford vouchers of seeds of Threatened Flora.

- Managed and supported by the curatorial staff, volunteer participation again was significant, totalling 19 544 hours (equivalent to 11.3 FTE).
- Tasks carried out and/or assisted by volunteers were as follows:
  - Mounted 16 222 specimens.
  - Assisted in the curation of specimens.
  - Assisted in the incorporation of 28 819 specimens that were added to the collection this year.
  - Completed the DELTA scoring of another genus, *Grevillea*. Extended descriptions and interactive key to be launched shortly.
  - DELTA scoring commenced for *Dryandra*.
  - Extended descriptions of *Hakea* and interactive key completed and made available on the intranet.
  - Validating plant chemistry vouchers, 1 073 out of 1 290 specimens now completed.
  - Validated 2 870 doubtful location outliers.
  - Continuing the validation of the 6 000 specimens of the W E Blackall collection.
  - Curated Droseraceae, *Austrostipa*, *Eucalyptus, Verticordia, Calandrinia* and native grasses.
  - Photographed type specimens.
  - Captured and prepared composite images for FloraBase (see below).
  - Increased the collection and documentation of Myxomycetes to 27 genera and 70 species.
  - Maintained and increased the number of taxa represented in the Reference Herbarium. The Reference Herbarium now has 13 397 specimens representing c.11 000 taxa. Over 1 600 visitors have used this resource to identify their plant specimens.
  - The state-wide Regional Herbarium Network continued to be supported with identification validation, vouchering and databasing. 1 616 specimens from the regional herbaria were identified and added to the collection. Contribution from Regional herbaria now total 21 776 specimens.

Future direction(s)
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), A Chapman (1.0), A Spooner (0.3), R Cranfield (0.9), M Trudgen (0.4), J Wege (1.0), BS Mahon (0.5), B Richardson (0.6); Total (6.9).

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 and main findings
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).
- Taxonomy studied in *Tetratheca*, *Lomandra, Wurmbea* and other plant groups, especially in Warren Region (T Macfarlane).

Taxonomy of the family Poaceae

- *Amphipogon* revision amended (T Macfarlane).
- *Austrodanthonia* revision in WA commenced with study of presumed new species (T Macfarlane).
- *Austrostipa* fieldwork in southern Jarrah forest on possible new species (T Macfarlane).
- Botanical support for Quarram grassland management team (T Macfarlane, R Cranfield).

Taxonomy of the family Epacridaceae

- Extensive specimen study, collection and re-identification in *Leucopogon*, improving the standard of identification in the collection, and veracity of FloraBase output (A Chapman, M Hislop).
- Paper describing 2 new species in *Brachyloma* submitted to Nuytsia (R Cranfield)
- Research into the relationships of WA *Monotoca*, including description of a new species (A Chapman).
- Collaborative research commenced on generic concepts, especially within the tribe *Styphelieae*, involving the WA Herbarium, Edith Cowan University and Royal Botanic Gardens, Sydney.

Taxonomy of the family Myrtaceae

- Paper in press for *Astus* (M Trudgen & B Rye).
- Taxonomic revisions underway on *Astartea, Babingtonia sens. lat., Enekbatus* (new genus), *Cyathostemon* (reinstated genus), *Oxymyrrhine* (reinstated genus)*, Pterocarpus* (new genus)*, Scholtzia, Seorsus* (new genus), and new species of *Micromyrtus* (B Rye and M Trudgen).
- Several papers submitted or in preparation (B Rye and M Trudgen).
- Paper on *Agonis* and relatives now in press (J Wheeler and N Marchant).
- Progress on manuscript preparation for revision of *Chamelaucium* (N Marchant).
- Continuing studies of *Darwinia* (N Marchant).

Taxonomy of the family Asteraceae

- Work has virtually been completed on the study of a group of species that are currently placed in *Helichrysum* (Asteraceae). *Helichrysum* is now recognized as being endemic to Africa and Eurasia. All Australian species of *Helichrysum* are being transferred to other genera, many of them new (P Wilson).
- During the past 2 yrs the Australian-wide genus *Xerochrysum* has been revised with 8 species recognized, and a new genus, *Coronidium* ms, established which comprises 16 species, all from the Eastern States and Tasmania. Revisions of the 2 genera will be published and texts prepared for the Flora of Australia (P Wilson).
- Continuing studies of tribe Astereae, including manuscript preparation for descriptions of new species of *Olearia* and 2 new genera from the Pilbara region (N Lander).

Taxonomy of the family Proteaceae

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

- Systematics and Conservation of *Lambertia*: literature review and significant field work towards a reassessment of the taxonomy of this group (A Spooner).

Taxonomy of the family Chenopodiaceae

- Supervision of PhD project on subfamily Salicornioideae (Samphires) continued (T Macfarlane).
- Paper on chromosomes in the group published (K Shepherd *et al.*).
- Papers on molecular analysis of phylogeny (K Shepherd *et al.*); fruit and seed structure (K Shepherd, T Macfarlane *et al.*), in press.
- Paper on morphological analysis of variation and phylogeny in preparation (K Shepherd, T Macfarlane *et al.*).

Taxonomy of lichens (R Cranfield)

- Census of lichens for WA amended.
- WA Herbarium collections reviewed.
- Fieldwork with international lichen specialists.
- Attendance at lichen group filed excursion in NSW.
- Examination of collections at NSW and Canberra herbaria, aimed at assessing WA lichen records unrepresented in WA collection.
- Identification of FORESTCHECK lichens.

Taxonomy of the family Stylidiaceae (J Wege)

- Extensive curation of the *Stylidium* collections at PERTH, NSW, CANB and MEL.
- Substantial field collection effort in Spring 2003. Vouchered photographs are gradually being made available to FloraBase.
- Taxonomic clarification of several species complexes, including the description of 7 new species and the reinstatement of 2 species.
- Ongoing data collation and generation of species descriptions for the *Flora of Australia* treatment, and the interactive key to trigger plant identification.
- Amendments to the conservation priority list suggested, including the recognition of 8 new Priority species.

Papers submitted for review:

- *Stylidium diplotrichum* (Stylidiaceae): a new scale-leaved trigger plant from south-west Western Australia, with taxonomic and anatomical notes on allied species.
- Reinstatement of *Stylidium rigidulum* (Stylidiaceae), with notes on the morphologically allied *S. kalbarriense.*
- Taxonomic notes on the locket trigger plants from *Stylidium* subgenus *Tolypangium* section *Repentes.*
- Taxonomic observations on the *Stylidium leptocalyx* complex (Stylidiaceae).
- Taxonomic observations on *Stylidium spathulatum* (Stylidiaceae), with the description of 3 allied species from section *Saxifragoideae.*
- Description of *Stylidium hymenocraspedum* and the lectotypification of *S. maitlandianum* (Stylidiaceae).

Papers accepted for publication:

- Chromosome records for 5 trigger plants (*Stylidium*; Stylidiaceae) from northern Australia (*Austrobaileya*).

2. Weed taxonomy, biosecurity assessment and incursion monitoring

- Weed status list for WA maintained (BS Mahon).
- Weed species descriptive data for FloraBase, scoring continued (volunteers; A Spooner).
- Blackberry nomenclature and species amended on FloraBase with information from S. Aust. specialist

team, new collections obtained, identification workshop attended, liaison with CSIRO over biological control (T Macfarlane).

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

- Preparation of 3 parts for publication, containing approx. 46 papers and short communications.
- Preparation for an online presence for the journal allowing greater access to contents and abstracts as well as searching across papers and short communications published since inception.

Management implications

- Taxonomic research relates particularly to conservation of flora by providing a system of defined species which are communicated by their scientific names (which may be formal or the informal manuscript (ms) or phrase (pn) names). It also aims to provide the means for conservation staff to confirm the identity of the plants they are dealing with. The researchers also contribute to the maintenance of the herbarium collections which manages the vouchers on which the botanical identity of plants from populations is based, and present information to user via FloraBase.

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.
- Progress with ongoing taxonomic studies of various plant groups to improve knowledge of the flora.

CALM Region(s)
All.

IBRA Region(s)
All.

BIOLOGICAL INFORMATION SYSTEMS (BIS)

FloraBase

Core Function

FloraBase, the web information system for the Western Australian flora, has increasingly become the main means of communicating botanical taxonomic information. A major upgrade and provision for the staged introduction of new features was completed in July 2003. Since then regular updates have corrected problems noted by users, and contributed new features to the site. 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 and to conform to some of the requirements of the WA State Records Act (2000) – 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 revised image database to address issues helped along by an increasing number of donations of high-quality photographs, and requests for reuse of the photographs in other projects – commenced.
- 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 – ongoing.
- Addition of further maps and images – ongoing.

Botanical content aspects

- Maintenance of short descriptive data for all new species only (A Spooner, M Choo).
- Addition and maintenance of generic and family descriptions from the WAGenera project (T Macfarlane) – completed, maintenance ongoing.
- Review and definition of taxonomic names component, with relation to the upgrading of the WACENSUS system project progressing.
- Addition of an illustrated glossary – progressing.
- Addition of other descriptive datasets for Weeds of WA and the genus *Hakea* – progressing.
- Addition of a phylogenetic tool for exploring higher-level systematics of WA Flora – progressing.
- Addition of interactive keys – commenced.
- Addition of interactive mapping tools from NatureMap – commenced.

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.
- Training workshops to community conservation groups, CALM staff and the education sector – ongoing.

Major new version

- Publication of FloraBase2 online – completed.
- Official ministerial launch of FloraBase version 2 completed (21 November 2003).

Management implications

- With the introduction of FloraBase 2, access to authorative and accurate information on the State's flora has been greatly enhanced. Both the community and conservation staff are able to retrieve the most recent information on the name, features, status and distribution of all 12 559 currently recognised native and naturalised WA plant taxa. Consequently, conservation efforts across the State are made more effective by building on quality data in a readily accessible format from authoritative information systems. Continued training in best practice use of FloraBase and vouchering at the Western Australian Herbarium will further aid efficiencies in flora management within the State.

Future direction(s)

- Maintain the quality of the information and the adequacy of the software and hardware systems.
- Add new types of content to FloraBase, including interactive keys for identification of several plant groups.

CALM Region(s)
All.

IBRA Region(s)
All.

WACensus

Core Function

Team member
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 CALM 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 and main findings
- A total of 271 new names were added to WACensus, with 164 being new manuscript or phrase names and 107 names published.
- WACensus updates are regularly distributed to over 160 registered Max users on a monthly basis
- The WACensus system is currently being completely rewritten. The most important enhancements include: support for higher-level taxonomic hierarchies, common names, support for alternative taxonomies and a GUI interface.

Management implications
- All CALM systems utilizing WA plant names should be based on, or integrated with the WACensus database.
- Staff maintaining plant databases should be using Max and the regular WACensus updates to check name currency.

Future direction(s)
- A number of new projects are currently underway which deal with other organisms groups such as fungi, algae and lichens. WACensus is currently being updated to support names for those taxa. Work is midway on migrating WACensus to a GUI environment and should be completed around November 2004.

WAHerb
Core Function

Team member
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 and main findings
- A total of 27 278 records were added during the last financial year, including over 7 010 lower plants and fungi. Of these, about 14 000 were entered as part of the AVH project. Totals for conservation taxa are now: P1 – 3 570, P2 – 6 093, P3 – 10 803, P4 – 7 480, R – 5 463.
- As a result of GDA enablement, a substantial portion of the database was updated and cleaned to reflect more demanding data requirements.

Management implications
- WAHerb represents the most comprehensive database on WA Plants available. Managers should therefore consult with the Herbarium in a range of different situations including: updates on biodiversity or conservation status, plant identification, prior to surveys to clarify what is already known for a given area, identify knowledge gaps, etc.

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 split into categories to accommodate normalized data entry.

Australia's Virtual Herbarium (AVH)

Core Function

Team members

A Chapman (0.2), K Knight (0.2), E McGough (0.5), M Ware (0.5), S Arkeveldt (0.7), M Hislop (0.5); Total (2.0).

Aim

To progress the databasing of the backlog of herbarium specimens at the Western Australian Herbarium, ultimately contributing to all Australian Herbaria making their full holdings accessible online by the end of 2005.

Summary of progress and main findings

- 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.
- Approximately 14 000 records will have been processed this financial year. This added to the 33 705 in previous financial years yields a total of c. 47 700 specimens processed as part of the AVH since project commencement in 2001.
- An additional 14 200 AVH records have been edited for validation purposes, and 2 800 of these records were able to be given an improved identification.
- 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.

Management implications

- On completion, AVH will bring to bear all the major national vouchered plant collections, providing a significant verifiable plant conservation resource for Australia. This will aid planners, land managers and conservation staff by providing a continental view of Australian native and naturalised plant distributions. Work will still be required to provide a consensus classification of the flora to ensure optimal names-based data retrieval.

Future direction(s)

- Validation of geocode statement and identification will be continue to be prioritized to ensure a consistent quality across the national collection, projected to total 6 million specimens.
- The distributed web mapping application for AVH is being re-specified to ensure that the accumulating data is readily accessible through a reliable and intuitive interface.
- Mechanisms for the distributed sharing of plant name usage and correspondence between States will need to be developed, and discussions by national groups such as the Herbarium Information Systems Committee (HISCOM) have commenced.

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 and main findings
- 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.
- Beta testing was completed and DELIA was installed.
- DELIA is being successfully used for new descriptive data projects (e.g. WIN, Ptilotus and Hakea). Typically, it is used to provide the link between descriptive data and data in our other corporate systems (e.g. WACensus), and through all the different phases of a project. At the start of a project, it is normally used to generate templates of current species. At any time during the project it may be used to interface with DELTA to generate directive files and call the relevant DELTA module/s. When coding and scoring is completed, it is used to populate distribution and data for other 'auto-characters'. At any stage, it may also be used to create and explore new characters.
- A corporate module (DELIAC) has been developed to integrate the 'DESCAT' database (the source of FloraBase descriptive data) with DELIA. This module will serve to rationalize the DESCAT system and will replace the no longer supported, original Paradox extract for FloraBase.

Management implications
- DELIA provides a tool for the department to corporately manage its taxonomic descriptive data.
- It allows DELTA projects to be integrated and managed under an institutional umbrella where resources may be allocated and procedures can be rationalised and streamlined.
- Provides the department the mechanism to collaborate and work with other external sources on DELTA descriptive projects.

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.
- DELIA will be used to rationalize the interface between the DESCAT database and FloraBase, providing a more streamlined approach for managing FloraBase descriptive data.
- It will continue to be used for creating and managing new descriptive data projects and integrating these with those already being managed by DELIA. Existing projects being managed outside DELIA's institutional umbrella could be integrated when resources are available.
- It will continue to be a tool to complement the DELTA suite of programs, providing features that are missing in DELTA (like managing multiple projects).
- A draft copy of a 'Methods' paper for taxon is now ready. Another draft describing DELIA's approach to managing taxonomic data, targeting the same journal will be ready shortly.

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 and main findings
- A development version of NatureMap continues to be tested by a selected number of CALM staff.
- Servers have now been deployed to host NatureMap.

Management implications

- NatureMap will provide CALM staff with sophisticated spatial querying ability to analyse point distributions of plants and animals within a range of commonly queried areas such as CALM estate, administrative districts, shire boundaries etc. Managers will therefore be able to more effectively assemble information on the biota for a given area without the need to purchase high-end graphics workstations or expensive GIS software licenses.

Future direction(s)

- 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 and main findings

- A new version of Max has almost been completed. The new version will be completely based on the Access data format and has much improved data handling capabilities. The Interface has been substantially improved with significant attention paid to assisting basic users. Max has been better integrated with WAHerb and will soon have a number of different forms for specialized access.
- Over 300 users have registered to use Max with over 160 registered to receive regular monthly updates to names. Over 9 282 records were added to WAHerb using MAX over the last 12 mth period, thereby avoiding re-keying.

Management implications

- Max provides a standardized way for updating and maintaining specimen information. Managers are highly encouraged to use Max in plant surveys to take advantage of integrated name-checking capabilities and WAHerb-compatible Electronic Collecting Book.

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.

Biodiversity analyses

Core Function

Team member

P Gioia (0.1); Total (0.1).

Aim
To investigate the potential for biodiversity analyses of the State collection.

Herbarium databases have historically been regarded as repositories for unrelated and specialized datasets with little potential for analysis. However, the random nature of data contribution over time in fact provides a great potential for broad-scale biodiversity information to be derived from the specimen label information. The Collection should be seen as the most comprehensive repository on plant biodiversity information available for Western Australian plants.

Summary of progress and main findings
- The collection has been analysed to determine the effects of collector bias on various biodiversity metrics such as species richness and endemism. Results show that while collector bias influences the relative magnitude of these metrics the underlying patterns are real.
- Species richness and endemism analyses have been conducted for southwestern Australia. Two papers have been written thus far (1 in press) and a book is planned for commencement early next year.

Management implications
- The initial results provide a new index for understanding patters of biodiversity within South-western Australia. These indices should be incorporated into future planning activities of the Department, particularly those involved in prioritizing areas for conservation.
- The State Collection is a prime resource for broadscale biodiversity information. The maintenance of the Collection, and the related databases which capture specimen label information, is of high importance to the Department, and because of the vouchered nature of the database, analyses are repeatable over time, even with changes in taxonomy. Managers should therefore look to the Collection as a live, ongoing strategic dataset that could potentially influence and support many conservation planning decisions.

Future direction(s)
- A book is planned for commencement early in 2005.
- Additional analyses planned include richness and endemism broken down by family groups.

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 and main findings
- The Woodvale server has been replaced with new server and high-capacity backup infrastructure.
- Switches at Woodvale and Herbarium have been identified for replacement.
- Ongoing performance problems at Woodvale have been identified in particular applications, particularly Financials. Continuing to liaise with ISS to provide solution.
- Line speed connecting Woodvale to Kensington has been analysed and will be upgraded to higher capacity.
- Ongoing support for Manjimup.

Management implications

- The Divisional LAN/WAN provides the main conduit for communication between Science Centres. Support for the ongoing maintenance of the LAN is crucial to the ongoing functioning of the Division. Problems such as the ongoing performance problems at Woodvale require ongoing high-level attention so that staff time is used more effectively.

Future direction(s)

- Disk capacity and backup facilities at Kensington have been significantly upgraded by installation of a new storage area network. This will more than double existing storage availability for Kensington-based Science staff as well as provide enhanced backup and retrieval capability.
- Switches and cabinets to be replaced at Herbarium and Woodvale.

BIODIVERSITY CONSERVATION GROUP

Group Manager: Keith Morris

Animal ethics
Core Function

Team members
K Morris (0.05), N Marlow (0.05), J Smith; (0.3), other members P Mawson (Wildlife Branch), E Bennett (Consultant), J Butcher (Kanyana), G Archer (RSPCA), D Nickels (Veterinarian), N Cooper (WA Museum); CALM Total (0.4).

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

Summary of progress and main findings
- 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)'.
- Administrative Instruction prepared and endorsed by Corporate Executive.
- Standard Operating Procedures relating to fauna handling / research in the field developed.
- An approval application form was developed using the guidelines in the Code.
- Database of applications, staff competencies and annual reports developed.
- Following the introduction of the *Animal Welfare Act 2002* and regulations, research institutions now need a 'licence to use animals for scientific purposes', renewed annually.
- The new legislation requires annual reporting of current projects to the AEC committee and the appointment of general inspectors.
- 49 applications were approved in 2003/04, and 52 annual reports received.

Management implications
- Ensure compliance with the *Animal Welfare Act 2002.*

Future direction(s)
- Provide a copy of the renewed scientific licence to all staff involved in fauna handling / research.
- Continue to provide CALM staff with information and guidance on the *Animal Welfare Act* and regulations.
- Ensure staff have adequate knowledge regarding their obligations under the *Animal Welfare Act* through regional seminars etc.
- AEC Chair to provide an Annual Report to the Corporate Executive and Department of Local Government and Regional Planning.
- Maintain existing databases on Animal Ethics issues.

BIOLOGICAL SURVEY AND RESERVE SYSTEM

Biological survey of the Pilbara Region (surface component)
SPP # to be allocated

Team members
N McKenzie (0.5), AH Burbidge (0.2), G Keighery (0.1); S van Leeuwen (0.2), K Morris (0.05), J Rolfe (0.1), B Bromilow (0.1), N Gibson (0.2), L Gibson (1.0), D Pearson (0.1), B Johnson (0.05), S Patrick (0.3), B Muir (0.1), A Pinder (0.95), M Lyons (0.6), S Halse (0.1), J McRae (1.0), D Mickel (0.5); Total (6.15).

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 and main findings
- 45 aquatic sites sampled once or twice for plants, invertebrates and waterbirds; invertebrate samples from 13 sites sorted to yield more than 500 species.
- Regular counts of ca 25 000 waterbirds on Fortescue Marsh when flooded.
- Half (151) of sites selected and survey quadrats/pit traps established.
- Invertebrate collections commenced at 151 sites, and sorting of specimens begun.
- Botanical sampling commenced at 151 sites.
- April 2004 sampling of terrestrial vertebrates postponed because of heavy summer rains.
- Submission of funding application for $500 000 under the auspices of the Priority Projects initiative to the Rangelands NRM working group.

Management implications
- Limited to date, however, there will be management implications following from achievement of each of the above items.
- Identification of several populations of Natal redtop (*Rhynchelytrum repens*), an invasive environmental weed which was associated with infrastructure corridors in the central Hamersley Range.

Future directions
Finish sampling plants, vertebrates and invertebrates at the first 151 sampling sites by June 2005.

CALM Region
Pilbara.

IBRA Region
Pilbara.

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

Team member
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 and main findings
Field work complete, databasing complete, papers published on conservation status of the flora of the Warren, and on flora of Scott River NP & Gingilup Swamp NR, voucher collections lodged WA Herbarium.

Management implications

- The flora of the Warren is generally well conserved, endemics are centred on swamps, granite rocks and to a lesser degree tall eucalypt forest. Wetlands of Scott River NP & Gingilup Swamp NR are highly diverse and any proposal for mining or water extraction from the Yarradagee in this are will need to address the very high biodiversity values of these areas.

Future direction(s)
Further papers to publish.

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

IBRA Region(s)
Jarrah Forest, Warren.

Floristic survey of the Goldfields ranges

SPP # 1993/0166

Team member
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 and main findings
Two further papers in press bring to a total of 7 papers published on detailed studies on the flora and vegetation of these ranges. These surveys have highlighted the high conservation values of these ranges in terms of unique vegetation communities specific to individual ranges, have identified 6 previously unknown taxa, and have documented patterns of local and regionally endemic taxa.

Management implications

- Continues to highlight the undocumented biodiversity of these ranges both in terms of flora and vegetation communities.
- Allows detailed assessment of mining proposals on those ranges for which detailed survey is available.

Future direction(s)
Synthesis paper to publish.

CALM 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 (0.1), colleagues from Pilbara Regions; Total (0.3).

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.

Summary of progress and main findings
- 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.

Management implications
- Highlighted biogeographical significance of the Nature Reserve with respect to the transitional nature of the flora, fauna and botanical communities.
- Reaffirmed fire management requirements and need for feral animal control, especially in proximity to significant but very restricted habitats.

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.

CALM 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 and main findings
- 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.

Management implications
- Confirmed importance of Karijini National Park with respect to botanical values in regard to hilltop flora.
- Reaffirmed need for implementation of Mulgalands Conservation Reserve to ensure adequate protection for flora and floristic communities not represented in the National Park.
- Confirmed requirements for a conservation reserve in the western 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.

CALM Region
Pilbara.

IBRA Region
Pilbara.

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

SPP # 1993/0038

Team members
G Keighery (0.1); N Gibson (<0.05) 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 and main findings
- 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

Management implications
- New Declared rare taxa being identified and listed.
- Advice to all Government departments on flora conservation values of area.
- Advice for development proposals (urban and mining) to industry and EPA.
- Major component of Perth Biodiversity Project (advising local Government on local biodiversity).

Future direction(s)
- Complete taxonomic papers.
- Participate in project to deliver results to Perth Biodiversity Project and other NRM groups.
- Complete paper on phytogeographic patterns across coastal plain.

CALM 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 and main findings
- Field work complete, databasing complete, preliminary analysis commenced.
- Documents long term impact of dieback disease on native flora in natural sites.
- Guide likely success of re-introduction proposals.
- Enable targeting of species most vulnerable to loss in control measures.

Management implications
- Long term understanding of the impact of dieback.

Future direction(s)
Several papers to publish.

CALM 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 Australia with a particular emphasis on Western Australia. In particular, to identify specimens from various aquatic projects, describe new species and summarize knowledge of zoogeographical aspects.

Summary of progress and main findings
- Identified further specimens from the stygofauna and surface water fauna components of the Pilbara Biological Survey
- Recognized numerous undescribed species from the above projects, and bgan to describe some new species and a new genus.
- Attended an international conference on the biology of aquatic oligochaetes in The Netherlands and presented a paper on the diversity of distribution of aquatic oligochaetes in subterranean habitats in Western Australia.
- Published 1 paper describing first Australia records of some cosmopolitan species.
- Identified oligochaetes from East Timor for the Federal Department of the Environment and Heritage, for the Australian Museum (Dr W Ponder) and for the Western Australian Museum (Dr W Humphries).
- Entered further data into the Australina Biological Information Facility (ABIF) a web-based diversity

database co-ordinated by ABRS (an electronic zoological catalogue). This is now available online at http://www.deh.gov.au/cgi-bin/abrs/abif-fauna/tree.pl?pstrVol=OLIGOCHAEYA&pintMode=1

Management implications
- Improved knowledge of the taxonomy of oligochaetes allows their conservation to be planned properly because correct decisions will be made about conservation status, distribution and scientific/genetic importance of the species.
- Improved knowledge allows oligochaetes to be used as ecological indicators of ecosystem health.

Future direction(s)
- Continue to identify specimens collected during the Pilbara stygofauna (SPP # 2002/004) and Pilbara surface water surveys.
- Publish descriptions of 2 new species.
- Co-edit an issue of Hydrobiologia (a leading international aquatic science journal) on Aquatic Oligochaete Biology (the proceedings of the 9th International Symposium on Aquatic Oligochaetes).
- Work on a review of the occurrence of aquatic oligochaetes in subterranean habitats in Western Australia.
- Apply for funds from ABRS to employ someone to produce an interactive key to Australian freshwater oligochaetes.
- Improve curation and databasing of my collection.

CALM 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 and main findings
- 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.
- Terrestrial flora paper in press Records of WA Museum.
- Wetland flora paper submitted.
- Terrestrial biodiversity paper in press.
- Recovery catchment paper currently being written up.

Management implications
- Projected 10 recovery catchments expanding to 25+, 6 underway.
- Biodiversity advice for Ministerial Committees and Technical working groups on Salinity.

Future direction(s)
- Publish report.
- Future usage being considered (web based delivery).

- Engineering and Drainage Evaluation Group (Ministerial appointment).

CALM 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.

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 and main findings
- Completed all botanical identifications and proved mounted and labelled vouchers to the PERTH herbarium and numerous eastern states institutions.
- 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.

Management implications
- Confirmed importance of Karijini National Park with respect to botanical values.
- Reaffirmed need for implementation of Mulgalands Conservation Reserve to ensure adequate protection for flora and floristic communities not represented in the National Park.

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.
- Provide advice to regulatory agencies on the conservation significance of tussock grassland habitats in the Hamersley Range.

CALM 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; CALM 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 and main findings
- Completed botanical collecting trip to previously unsurveyed areas within the Jilyili Hills, Lake Sunshine and Beyondie Lake area.
- Submitted a consignment of mounted and labelled voucher specimens to the Perth Herbarium and associated institutions in the eastern states.

Management implications
- Proposal for a new conservation reserve in the south-western Little Sandy Desert developed and submitted to the appropriate authorities for consideration.
- Extend of land and vegetation degradation caused by camels raised as a significant management issue.

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.
- Provide advice and recommendations to land management agencies on the requirements for a conservation reserve in the south-western Little Sandy Desert.

CALM 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 and main findings
No further activity on this project since sites near Kununurra were surveyed last year.

Management implications
- Fire and grazing prescriptions appropriate for the regeneration and protection of boabs in the Kimberley region.

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 Western Australia*.

CALM Region
Kimberley.

IBRA Region
Victoria Bonaparte.

Directory of important wetlands in Australia: revised editions

SPP # 1999/0014

Team members
J Lane (0.15), G Pearson (0.1), A Clarke (0.2), S Elscot (0.25); 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 and main findings
- Funding was provided from Environment Australia's Natural Heritage Trust National Funding Program in May 2003 for CALM to undertake work leading to the nomination and improved documentation of nationally important wetlands in under-represented IBRA regions of the State.
- Representation of Western Australian wetlands in the Directory has been reviewed.
- Attention is now being focused on IBRA regions with few listed sites. Wetland literature relating to these regions and sites has been collated and is being analysed.
- This literature, specialist knowledge and existing biophysical maps, photographs and satellite images is being used to plan a program of wetland data and knowledge acquisition. The Nullarbor and Ord Victoria Plains IBRA regions are being focused on initially.

Management implications
- Literature search and field survey results will lead to identification of nationally important wetlands, values and threats and provide a basis for conservation and wise use management of these wetlands.

Future direction(s)
- 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.

CALM Region(s)
Kimberley, Pilbara, Goldfields, Midwest, South Coast, Wheatbelt.

IBRA Region(s)
Main focus is on Central Ranges, Coolgardie, Gibson Desert, Great Victoria Desert, Hampton, Little Sandy Desert, Mallee, Nullarbor, Ord Victoria Plains, Tanami, Yalgoo.

Identification and monitoring of benthic invertebrate communities of tropical intertidal mudflats

SPP # 1999/15

Team member
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 and main findings
Roebuck Bay
A study of the food webs of Roebuck Bay using stable isotopes was initiated in 2003. Results will be reported in August 2004.

- Continued participation in a postgraduate study of the bivalves of Roebuck Bay in collaboration with RNIOZ. 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.
- The book 'Life along land's edge' Wildlife along the shores of Roebuck Bay was released on April 21 in Perth and on April 28 in Broome.
- Collaboration with community groups on a second Celebrate the Bay community based information forum in Broome.
- Continued collaboration in the Shorebird Conservation Project at Roebuck Bay with WWF, Rubibi and CALM.

Eighty-Mile Beach
A study of the food webs of Eighty Mile Beach using stable isotopes was initiated in 2003. Results will be reported in August 2004. Funding was obtained from CALM's Wetland Project proposals.

- Initiated analysis of data collected from the Eighty-mile Beach monitoring ('Monanna') Project.
- Continued collaboration with District staff to progress the development of a dual use management zone between the Ramsar site and pastoral activities.

Management implications

- Roebuck Bay is a Ramsar site and a proposed marine conservation reserve. The information gathered from these projects will assist better understanding of relevant management issues at Roebuck Bay and its hinterland. Similar implications apply to Eighty-mile Bach and its hinterland.
- Management strategies and opportunities for research for both sites will be enhanced by collaboration with external research institutions.
- Improved community understanding of management issues at Roebuck Bay and Eighty-mile beach.

Future direction(s)
Roebuck Bay

- Completion of a food-web study of the Bay incorporating use of stable isotopes, by RNIOZ, University of Western Australia and CALM.
- Collaborate with Rubibi Aboriginal Group in a monitoring program of mangal and benthic communities at Roebuck Bay.
- Monitoring of the benthos at 4 sites in Roebuck Bay continues through collaboration with Broome Bird Observatory.
- Potential for sea grass studies at Roebuck Bay through collaboration with scientists from The

Netherlands.
- Develop criteria for a program that examines the value of cattle grazing on buffle grass plains to shorebirds.

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.
- There is progress towards the production of a book on Eighty-mile Beach that illustrates the conservation values of the Ramsar site and its hinterland.
- Develop criteria for a program that examines the value of cattle grazing on buffle grass plains to shorebirds.

CALM Region
Kimberley.

IBRA Region
Dampierland.

Floristic survey of the Darling Scarp
SPP # 2002/0007

Team member
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 and main findings
Field work completed, databasing completed, voucher collection lodged WA Herbarium, report by consultant completed.

Management implications
- Provides information of conservation status of the plant communities of the Scarp both on CALM and other public lands.

Future direction(s)
Several papers to publish.

CALM 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 and main findings
- Project completed and ms submitted for publication.
- Voucher material deposited in WA Museum.
- Invertebrate fauna of saline lake beds differs from that in samphire or in woodland.
- Invertebrate faunas of saline lake beds vary regionally.

Management implications
- Saline lake floors need to be conserved on a regional basis to encompass the known geographic variation in the fauna.

Future direction(s)
- Project completed.

CALM Region(s)
Wheatbelt, Midwest.

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

Biological survey of the Pilbara Region (stygofaunal component)
SPP # 2002/0004

Team members
S Halse (0.6), S Eberhard (1.0), M Scanlon (1.0); J Cocking (1.0); H Barron (1.0); Total (4.6).

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 and main findings
- 360 samples collected from 270 boreholes have been sorted and identified. To date approximately 200 species have been recognized, with the copepod (descriptions of 43 species prepared for publication) and ostracod faunas being particularly diverse and the amphiods offering considerable taxonomic difficulties.

Management implications
- Many stygofaunal species have less restricted distributions than previously thought, making their conservation easier.
- The stygofaunal community of the Pilbara is very rich by world standards, making its documentation and conservation important.
- Stygofauna occur in most geological substrates of the Pilbara – they are not restricted to karst, calcrete and alluvium, so that their conservation is an issue for all development likely to impact on the water-table.

Future direction(s)
- Additional sampling, more geographically widespread and in a greater range of geologies, will be undertaken.
- Groundwater will be mapped, using water chemistry to identify flow paths and aquifers.
- Relationship between genetic and morphological variation in amphipods will be investigated and new species described.
- Additional new species of copepod and ostracod will be described.

- A workshop of all Australians currently working on groundwater fauna will be held in Perth in October 2004.

CALM 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), Total (1.5), and Kimberley Region staff.

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 and main findings
Field work of drier, central parts of Kimberley undertaken in June 2004. Preliminary analysis of these results indicates that medium sized mammals have declined in this area, when compared with the wetter coastal areas surveyed last year. It was also noted that pastoral activities (cattle present, stock yards erected) have extended into conservation areas and this is having a detrimental impact on habitat.

Management implications
- A review of status of Kimberley mammals.
- Provide advice on management of fire regimes in the Kimberley.
- Highlight the need for better boundary management of conservation reserves, and improved neighbour liaison.

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, and drier central parts of the Kimberley have altered in recent decades.
- 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.

CALM 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 and main findings
- 'A Biodiversity Audit of WA's 53 Biogeographical Subregions in 2002' published by CALM.

Management implications
- Provides a framework for the management of CALM estate.

Future direction(s)
- Transfer results to operations.
- Maintain currency of Audit.

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 and main findings
- 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 (3 plots at Lindsay block), were completed and an autumn treatment at McCorkhill block was attempted but failed to burn due to light fuels and high moisture content (20%). These will be carried over and added to next year's program.

Management implications
- Appropriate fire regimes for the conservation of floristic diversity in southern forest uplands.

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.

CALM Region(s)
Warren, South West.

IBRA Region
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 and main findings

- One paper published (*Journal of Arid Environments*) and one paper in press (the review of Western Shield).
- The Gibson Desert Nature Reserve (GDNR) study site has been temporarily abandoned because of wildfire impacts; most of the reserve has been burned. The study was relocated to Lorna Glen, east of Wiluna.
- Following successful baiting in the GDNR in 2002, successful medium scale fox, dog and feral cat baiting trials were carried out on Lorna Glen in winter 2003 resulting in an estimated 96% reduction in cat density. Ongoing monitoring has shown that feral cats began to re-invade 6 months after baiting, suggesting baited area needs to be larger.
- Additional small vertebrate pitfall trap grids were established. Trapping of small mammals and reptiles has shown that cat prey availability is low over the cold winter months.
- Fire ecology (plants) and invertebrate monitoring sites were established and assessed. Data are being analysed.
- Fire history and fuel age maps have been prepared.

Management implications

- There is a need to manage fire in the arid zone to reduce the severity of wildfires.
- Science-based guidelines for managing fire and introduced predators in the arid zone, This project should lead to the reconstruction and protection of arid zone mammals and other elements of the biota.

Future direction(s)

- Complete analysis and write-up of first stage of fire ecology (plants) study.
- Write-up and publish results of baiting trials at Lorna Glen.
- Carry out large-scale operational baiting trial at Lorna Glen winter 2004.
- Monitor re-invasion of feral cats at Lorna Glen after winter 2004 baiting
- 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 GDNR and Lorna Glen.

CALM Region
Goldfields.

IBRA Region(s)
Gibson Desert, Gascoyne.

Fire effects on desert vertebrates

SPP # 1993/0092

Team member
D Pearson (0.1) Total (0.1).

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 and main findings
- 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, leading to the termination of the field component of the study in March 2003 with the removal of most traps.
- Spider samples were identified by P Langlands, an Honours student at Curtin University and form the basis of his thesis.

Management implications
- The season and intensity of fires have profound effects on the terrestrial vertebrates in spinifex grasslands. Patchy spring fires enhance local diversity but create opportunities for open areas specialists. Extensive summer fires remove several mammal and reptile species. Patchy spring fires are the preferred fire management strategy to conserve biodiversity in these grasslands.

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

CALM 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 and main findings
- Continued plant identification process and refinement of floristic database.
- Continued 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.

Management implications
- Advice provided to regulatory authorities on the likely impacts of mining developments on mulga woodlands.

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.
- Ongoing sorting on invertebrate samples and commence identification of ants.
- Refurbish permanent inventory sites and undertake a sampling session.
- Ongoing liaise with Ecosystem Research Group, School of Plant Biology, and the University of Western Australia over preparation of manuscripts for 'Pilbara Disturbance Ecology' book.

CALM Region
Pilbara.

IBRA Region
Pilbara.

Monitoring of Carnac and Penguin Island Silver gull populations
SPP # 1999/0012

Team members
J Lane (0.05); other CALM 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 CALM's Perth metropolitan area gull management plan.

Summary of progress and main findings
Numbers of gulls on low-level, oblique, aerial photographs of Carnac and Penguin Islands taken in May 2003 were counted. Trends in gull numbers on these 2 islands over the 10 yrs since 1994 were determined. There was a strong decreasing trend on Penguin Island and a significant overall decrease in numbers on the 2 islands combined. No further surveys are planned for several years.

Management implications
- The decline in Silver Gull numbers on Penguin and Carnac Islands suggests that efforts to reduce gull access to artificial food sources and thereby limit gull numbers in the greater Perth metropolitan area are having the desired effect. It is possible, however, that other factors have caused or contributed to the observed decline. Further consideration of the survey results and related information is required before firm conclusions can be reached.

Future direction(s)
A report on trends in annual gull numbers on Carnac and Penguin Islands during the period 1994-2003 will be prepared. This report will contribute to a Departmental review of Silver Gull management in the greater Perth Metropolitan Area.

CALM 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 (0.4), N Gibson (0.05), D Mickel (0.5); Surface water - J Lane (0.35), G Pearson (0.1), A Clarke (0.6),), S Elscot (0.1), Y Winchcombe (0.3), B Johnson (0.05); Groundwater - S Halse (0.05), contracts; Total (3.3).

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 and main findings
- 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.
- Surface water monitoring – 2003 monitoring completed; database corrections and update completed; analyses of 1978-2000 depth and salinity data from 151 wetlands completed, compilation of draft 1978-2000 report well advanced.
- Wetland bathymetry – field surveys of lake bed, shoreline, inflow and outflow contours of Lakes Gore, Quallilup, Shark, Mears and major part of Yenyenning lakes completed, and maps and depth-volume calculators prepared. Field surveys of Lakes Taarblin (north section), Ardath, Wallambin North and Campion completed. Mappingog yenyenning Gore, Quallilup, Shark and Mears Lakes completed.
- Publicity – filmed Post Cards WA segment on faunal aspects of monitoring program was to be screened in June 2003.
- Vegetation monitoring for 2003/04 completed, collaboration began with CRC for Plant based Management of Dryland Salinity on detailed measures of soil and plant vigour.
- Ground water monitoring for 2003/04 completed, data logger installation completed, groundwater bores surveyed into vegetation transects.
- Paper on 5 yrs monitoring of vegetation monitoring in the Lake Muir-Unicup wetland system submitted.
- Management – contributed to Bryde, Buntine-Marchagee, Drummond, Muir, and Toolibin TAGs and provided advice to Warden Biodiversity Recovery Catchment, advised on biodiversity aspects of drainage issues in the wheatbelt.

Management implications
- Analyses of trends in depths and salinities of 41 wetlands monitored for 20 or more years have revealed several wetlands undergoing diverse changes that warrant further investigation and possibly corrective management.
- Evidence is growing that several waterbird species have been lost from wheatbelt wetlands over the past 20 yrs as a result of salinization and will not return unless salinities decrease and riparian and emergent vegetation is re-established.
- Surface water management is as important in some wheatbelt wetlands (such as Coomalbidgup Swamp) as groundwater management in maintaining wetland health and greater focus on surface water is required.
- Annual changes in wetland conditions as a result of drought or high-rainfall events affect the use of wetlands by invertebrates, waterbirds and plants. Wetland condition cannot be easily assessed without understanding where a wetland is in the hydrological cycle and having information on its capacity to recover from perturbation (such as extreme flood events), which is often determined by the frequency of recent perturbations.

Future direction(s)
- Continue monitoring according to current protocols.

- Reports on trends in depth, salinity and acidity/alkalinity of monitored wetlands from 1978-2000 to be completed.
- Investigations into causes of changes in depths and/or salinities of several monitored wetlands to be initiated.
- Bathymetric maps of Lakes Taarblin (north section), Ardath, Wallambin North and Campion to be completed. Further bathymetric surveys to be undertaken.
- Monitoring bores to be surveyed to depth gauges.
- Analyse groundwater trends are 1 or 2 wetland areas as a case study showing value of monitoring.

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

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 and main findings
- Substantial progress was made in preparation of a report comparing the results of 1970s and 1990s surveys of waterbirds on Peel-Harvey Estuary. An extensive review of relevant ornithological literature was undertaken so that changes in abundance can be considered in broader contexts of species' life histories, changes in distributions and population abundance, etc.

Management implications
- Management implications will be assessed on completion of the 1970s to 1990s 'comparisons' report.

Future direction(s)
- The 'comparisons' report, comparing results of pre- and post-Dawesville Channel waterbird surveys will be completed.

CALM 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 Ramsar Site 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 and main findings

- 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 2003-04.
- Monitoring of fish activity and water levels at the floodgates was undertaken during 2003-04, initially by team staff and later (February 2004 onwards) by contractors to the Water Corporation during replacement of the floodgates. The Vasse estuary floodgates were opened on several occasions to maintain the target, summer-autumn, water level and to allow fish to pass.
- A meeting 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 replacement of the floodgates during 2003-04.
- The Team leader provided ongoing advice to the Water Corporation and its contractors concerning management of water levels and fish during replacement of the floodgates (January-June 2004).
- Advice was supplied in response to public queries about management of the wetland system and places to see waterbirds. Scientific advice was provided to the Busselton Shire concerning its proposal to establish a Busselton Wetlands Interpretive Centre and associated wetland experiences.

Management implications

- Water levels and flows were successfully managed throughout summer-autumn of 2003-04. There were no mass fish deaths, and adverse impacts on waterbird populations and fringing plant communities that would result from excessive water levels and salinities were avoided.

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 operation of the replacement (2004) floodgates from an environmental perspective. Public enquiries concerning management of the wetlands will be responded to.

CALM 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 and main findings
- 16 trapping sites established in Dec 2001.
- Sites trapped in Dec 2001, Feb 2002, Dec 2002, April 2003, Dec 2003 and May 2004.
- Volunteers trained in biosurvey methods in July 2002. Beetle identification workshop Dec 2003.
- Bio-Track seminar (E Ladhams of Macquarie University) on identification, curation and analysis.
- c. 1500 morphospecies sorted and added to Nuyts Collection by volunteers.
- Local curator Jacqueline Manning employed part time to supervise volunteers.
- 312 beetle species identified by honours student D Herath and validated by A Szito.
- Gary Muir (Walpole Wilderness Eco-cruises) setting up website and access database.
- A new microscope, digital camera and digital image program purchased for WNNPA.
- Located several new populations of the short range endemic millipede (*Cynotelopus notabilis)*. Another population of this millipede found in spring 2004.
- 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.

Management implications
- The Nuyts Invertebrate Collection contains 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.
- Analysis of the 312 beetle species collected indicates that more than two thirds of species are site-specific and are restricted to particular fire ages and microhabitats (floor, log, tree butts or hollows) within forest types (karri, tingle, marri and jarrah).
- Beetles occur in most feeding guilds present in forest ecosystems and represent c. 20% of Earth's biodiversity. The Nuyts beetles probably represent a major proportion of the biodiversity of the old growth forests. This beetle fauna is proving to be a sensitive indicator of fire management impacts and indicates a need to manage for a diversity of fire ages, of both recently and long unburnt patches within each forest type.

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.

CALM Region
Warren.

IBRA Region
Warren.

FAUNA RECOVERY AND CONSERVATION

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 mammal species in the Perup Nature Reserve (PNR) in 2 different fuel ages, twice per year (spring and autumn). This project commenced in 1972 and is one of the longest running mammal monitoring projects in Australia.
- 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 CALM Bushrangers in mammal conservation and handling.

Summary of progress and main findings
- Populations of Woylies are stable, with normal distribution curves for ages.
- Capture rate for Woylies remains high at c. 72%, with little variation between fire 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

Management implications
- Effectiveness of feral predator control (fox and cat) over time to assess the effectiveness of Western Shield baiting in the PNR.

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

CALM Region
Warren.

IBRA Region
Jarrah Forest.

Assessing the distribution and status of the Wambenger
SPP # to be allocated

Team members
N Marlow (0.50), C Ward (0.10), A Williams (0.50), J Rooney (0.10), C Vellios (0.1); regional staff - I Wilson, Total (1.30).

Aim
- To determine if significant recent changes in distribution of Wambengers have occurred and if so why.
- 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 and main findings
- 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 and nest boxes have been positioned therein.

Management implications
- If Wambengers are found to ingest sufficient Probaits that they are threatened at a population level, then operational baiting with Probaits may need to be restricted to areas from which Wambengers are absent.

Future direction(s)
- Monitoring of nest boxes will be undertaken annually in February and June.
- Wambengers will be radio-collared in baited and unbaited sites and their survival monitored during a toxic Probait baiting campaign.

CALM 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 and main findings
- Completed and distributed progress report on second year of fieldwork at remnant bushland sites on the Swan Coastal Plain (SCP), including initial data analysis of mark-recapture data and relationship between abundance and weather conditions.
- Completed 183 butterfly transect surveys at 21 metropolitan bushland sites comprising 25 fragments, and food- and nectar-plant surveys at each site. These included autumn surveys for the endangered graceful sun moth (*Synemon gratiosa*).
- Located 3 new sites for the graceful sun moth.
- Completed 3 abundance and habitat surveys of a proposed critically endangered butterfly (the Arid bronze azure, *Ogyris subterrestris petrina*) in Goldfields region.
- Obtained additional records of butterflies from the Kimberley region, expanding knowledge of butterfly distributions in WA.
- Deposited samples of the large bronze azure, satin azure and northern purple azure (*Ogyris idmo*, *O. amaryllis* and *O. zosine*) for DNA analysis with Griffith and Harvard Universities.
- Presented results of surveys to Friends of Trigg Bushland reserve.

Management implications
- More than 10 butterfly species are now locally extinct in the highly disturbed bushland remnants on the SCP, and therefore some reserves are likely to be of critical importance in maintaining landscape biodiversity.
- It is becoming apparent that a translocation approach, currently used successfully for endangered vertebrates, will be necessary to maintain butterfly biodiversity of the SCP.

Future direction(s)
- Complete and distribute report on third year of fieldwork.
- Prepare and publish paper on methods of surveying for butterflies and day-flying moths in Western

Australia.
- Conduct more surveys at additional sites in the fourth year of the study.
- Apply for funding for work on the arid bronze azure, a proposed critically endangered butterfly, and for the graceful sun moth.

CALM Region(s)
Swan, Goldfields.

IBRA Region(s)
Swan Coastal Plain, Coolgardie.

Conservation of marine turtles
SPP # 1993/0040

Team members
B Prince (0.75), K Morris (0.10), A Williams (0.05); Total (0.85); District staff from Denham, Exmouth, Karratha and Broome.

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 and main findings
- Action commenced on Limpus review recommendations, particularly in relation to monitoring abundance of nesting populations.
- Integrated tagging database developed.
- Participation in a community workshop at Exmouth to develop a beach nesting monitoring program.
- Participation in a national workshop to develop code of conduct for tourist interactions with turtles and dugong.
- Commonwealth marine turtle recovery team resurrected.
- Ongoing liaison with State and Commonwealth agencies regarding management of threats to marine turtles.

Management implications
- Provision of knowledge to allow adequate management of marine turtle stocks.

Future direction(s)
- Complete WA marine turtle management plan in liaison with Marine and Wildlife Branches.
- Continue involvement with the national recovery team.
- Continue to implement science based recommendations of turtle review, particularly with respect to developing monitoring protocols for nesting populations.
- Continue to liaise with Districts and other stakeholders regarding turtle management.
- Implement the integrated turtle database – linking tagging, mortality and recruitment factors.
- Develop a research program for marine turtles in the MoU Box, including Browse Island.
- Implement a study into the temperature profiles of nesting beaches along the north west coast.

CALM 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 (0.25), K Morris (0.05); Total (0.3).

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

Summary of progress and main findings
- Ongoing monitoring at key recovery / translocation sites completed.
- Collation of Western Shield chuditch monitoring data in preparation for conservation status review.
- Publication of a review of the recovery program for Chuditch (Predators with Pouches book: CSIRO).
- The potential for chuditch to eat cat baits in the field was assessed to be low.
- Planning for a trial to assess impact of Probaits on chuditch at Julimar Conservation Park.
- Monitoring of Cape Arid National Park failed to find chuditch.

Management implications
- Potential down listing of chuditch.

Future direction(s)
- Finalize analysis of trapping monitoring data available from Western Shield sites.
- Resurvey semi-arid reintroduction sites.
- Survey of Mukinbudin area following roadkill in the area.
- Undertake review of IUCN status.

CALM 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 (0.15), 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; CALM Total (0.15).

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 and main findings
Review of distribution and conservation status published (in press) and 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 quokkas 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).

These management actions are yet to be implemented.

Management implications

- The proposed interventive management (i.e. use of fire to manipulate habitat and create the preferred structural mosaic) and maintenance of fox baiting programs are recommended as necessary to ensure persistence of the northern jarrah forest quokka populations.

Future direction(s)

- 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.

CALM 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 CALM'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 1 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
AH 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 Western Bristlebird and increase its total population size.

Summary of progress and main findings
- In collaboration with regional staff, discussion paper concerning fire management at Waychinicup–Manypeaks presented at workshops on the South Coast.
- Monitored translocated population in Walpole–Nornalup NP and re-assessed options for further translocations.
- All contemporary and historical records brought into a digital environment, and records validated, for use in a GIS, to facilitate planning of specific management actions.
- Recovery plan drafted.

Management implications
- Improved basis for decision making concerning management, especially in relation to fire, in major conservation reserves on the South Coast.

Future direction(s)
- 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.
- Finalize recovery plan.

CALM 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 (0.6); J Jackson (0.4) Total (1.0).

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 and main findings
- The 2003-4 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.
- In 2004 the translocation program was recommenced at Leschenault, with initial monitoring indicating the only cause of mortality was predation by pythons (5 of 10 radio-collared ringtails were preyed upon by pythons).
- Habitat clearing at development sites in Busselton has resulted in the need to relocate 73 western ringtail possums from January to June 2004. The additional releases were at Leschenault and Yalgorup. A subset of the released possums is currently being monitored through radio-telemetry. The only deaths, at June 2004, were those attributed to python predation, above. The current monitored sample size (radio collared possums) is 18.

Management implications
- Translocation is yet to be shown to be a viable management strategy for rehabilitated western ringtail possums (ex wildlife carers) or for western ringtail possums displaced by developments. In the absence of demonstrated translocation success, CALM has no mechanism to deal with displaced or rehabilitated western ringtail possums.

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.

An MSc student (I Bertram, University of Glasgow, Scotland) will commence in July 2004 and will monitor survivorship at baited and unbaited sites. A collaborative program (CALM and Murdoch University, School of Veterinary and Biomedical Sciences) has commenced and will monitor the health status of rehabilitated western ringtail possums. Subject to the outcome of an ARC Linkage grant application, this will be expanded in 2005 to include health monitoring of possums taken directly form development sites and the

number of monitored sites translocation release will be increased to address this issues identified above.

CALM 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 and main findings
- 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 sixth year and monitored by radio-tracking. This is the fourth year of an experiment to determine the effect of predator training. Eight animals were released in December 2003 and the fate of 6 was determined. Two were known to be alive in May 2004. This year's data will be combined with previous years results to assess the effectiveness of the training in reducing mortality soon after release. Results indicate a positive effect of predator avoidance training.
- Mortality is principally due to predation by raptors.
- Driven surveys have been carried out at Dryandra Woodland, Tutanning and Boyagin NRs. Numbers at Boyagin and Tutanning are slightly up on last year.
- Two-day diggings surveys have been carried out at Batalling, Nockine Block (near Dale CP), Dragon Rocks and Karroun Hill NRs. Reintroduced numbat populations have persisted at Batalling and Dragon Rocks, but no signs were found in searches at Karroun Hill and Nockine.
- A workshop to instruct district staff in numbat diggings recognition was held at Dryandra in March. These workshops will be repeated with the aim of increasing district involvement in monitoring.
- The Numbat Recovery Plan is being revised and will be submitted in June 2004.
- Two sites proposed for numbat releases in South Australia were inspected in 2004. Trial translocations were proposed.

Management implications
- Further searches are required in the northern jarrah forest and at Karroun Hill NR before concluding that these reintroductions have failed. Fox control has been increased from 0-2 times to 4 times a year at Nockine since the releases and this site should be considered for further translocations.

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 numbats at Karroun Hill NR will be carried out in

2004/05.
- A review of Numbat translocations will be completed by the end of 2004. The revised recovery plan will be submitted for adoption by the Commonwealth in 2004.

CALM Region(s)
Swan, Wheatbelt, Warren, 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 (< 0.2).

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

Summary of progress and main findings
- 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 trapping session was conducted in April/May 2003.
- A report on the results of the study is currently being prepared.
- No monitoring was carried out during 2003/04 and there is currently no monitoring program for RTPs being carried out by CALM. Fox control ceased on 2 reserves that had been baited since 1994, creating an opportunity to refine this investigation the effect of baiting.

Management implications
- At this stage there is scant evidence that fox control is an important requirement for the persistence of remnant RTP populations.

Future direction(s)
- Results of this project will be written up during 2004. 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 is currently being written with NHT funding in 2003/04 and will involve community input. The plan recommends the continuation of this study.

CALM 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 member
P de Tores (0.10); Total (0.05).

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

Summary of progress and main findings
- Further survivorship analysis (information theoretic approach, use of model selection and Akaike Information Criteria [AIC]) demonstrated woylies within the 6 baitings per year treatment had a 10% higher probability of survivorship over the duration of the study than Woylies in the 4 baitings per year treatment.
- Further analysis will determine whether the probability of survivorship within the 6 baitings per year treatment is sufficient to enable the population to be sustained.

Management implications
- The implication is the current aerial baiting regime of 4 baitings per year for large areas of forest is insufficient to enable populations of predation-sensitive ground-dwelling species such as the Woylie to be sustained.

Future direction(s)
- Recommend that the standard 4 baitings per year prescription for aerial baiting be revised to a higher frequency (6 baitings per year).
- 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. Data will be analysed to provide conservation management recommendations which acknowledge the need for managers to incorporate multidimensional temporal and spatial aspects of habitat management with feral predator control.
- 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.

CALM 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); 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 and main findings
- 4 papers on this work published in international journals; 1 submitted to Austral Ecology and 2 in preparation.
- Ongoing sighting survey with CALM staff and the public; 1 publication on this aspect.
- Continued mark recapture studies on 2 populations; West Wallabi Island (100 individuals) and Garden Island (800 marked individuals) to collect long term population trend data, recruitment rates and growth data.
- Expedition to Mondrain Island to examine impact of recent fire on pythons and other fauna.
- Ongoing research on captive breeding of Woma pythons.

- Implantation of transmitters in 8 Woma pythons on Peron Peninsula and their monitoring by local CALM staff.
- Collection of material for taxonomic work on south-western population of Woma pythons.

Management implications
- Peron Peninsula appears to have a large population of Woma Pythons, but they are difficult to detect due to their cryptic behaviour and infrequency of movement. They prey on rabbits, but are a potential threat to translocated mammals.

Future direction(s)
- Woma python telemetry (2-3 yrs) and subsequent write-ups.
- In conjunction with CALM Midwest staff, undertake further searches to locate an extant population of Woma pythons in the northern Wheatbelt.
- Continue mark-recapture studies on Garden, West Wallabi and Mondrain Islands.

CALM Region(s)
Swan, Midwest.

IBRA Region(s)
Swan Coastal Plain, Geraldton Sandplains, Wheatbelt, 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 and main findings
- Workshop convened to discuss disease issues in the WBB and to map out future action. This aspect is now being covered under an ARC Linkage grant application with Murdoch University.
- A workshop to discuss a monitoring program for Bernier and Dorre Island mammals was held in October 2003.
- S Smith has commenced a PhD study at Griffith University determining genetic variability of island populations and derived mainland populations of WBB and other species. Pedigree analysis will also be carried out in order to determine the contribution of different founder individuals to the populations. A strategic collection of ear tissue samples has been sent to Griffith University for analysis.

Management implications
- The results of these studies, particularly relating to disease and genetics, will be of great value in managing wild populations and translocations.

Future direction(s)
- The results of the cross-breeding experiment conducted at Kanyana Wildlife Rehabilitation Centre commencing in 1994 will be written up in 2004.
- A paper on home range activity and nest use by WBB on Dorre Island will be completed during 2004.05.

CALM 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 and main findings
- Monitoring the reintroduced dibbler population at Peniup, the first mainland re-introduction site, 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. The third release of captive-bred dibblers (43 individuals) at Peniup was carried out in Oct 2003. However, in May 2004, only 1 dibbler was captured at Peniup, during a mouse plague. Monitoring will continue.
- Annabelle Stewart is continuing her 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, Waychinicup and Fitzgerald River NP. Hair tubing is now being used to reduce cost and increase coverage of surveys.

Management implications
- The study of mouse-dibbler interactions may have implications for mouse eradication on Boullanger and Whitlock Islands.

Future direction(s)
- Monitoring of the Peniup translocation and the FRNP populations will continue.
- A new translocation site will be determined early in 2004/05.
- Dibbler surveys will be extended eastwards in 2004/05, especially between Cheyne Beach and FRNP. Meanwhile the Denmark Environment Centre's Gilbert's Potoroo survey west of Albany using hair-arching also has the potential to discover dibbler populations.

CALM 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 (0.05); Regional staff Goldfields, Ngaanyatjarra and Western Desert Land Councils; Total (0.15).

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

Summary of progress and main findings
- 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 CALM-Ngaanyatjarra relationship in relation to Townsend Ridges to Goldfields Region.
- Monitoring other Rock-wallaby populations: Mondrain Island post-fire (with CALM South Coast), Barrow Island (with Science Division staff).

Management implications
- Fox baiting in the Townsend Ridges has ensured the continued survival and recovery of this genetically unique population.
- Rock-wallaby populations in the Townsend Ridges and on Mondrain Island successfully survived large fire events and may not be as sensitive to pyric disturbances as might be expected.

Future direction(s)
- Revision of project to focus on investigating appropriate monitoring strategies for different populations that can be conducted by management staff and Aboriginal contractors.
- Revision of the Rock-wallaby recovery plan (1991).
- 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 CALM 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, Cape Range and desert locations.

CALM Region
Goldfields, Pilbara, South Coast, Mid West.

IBRA Region
Murchison, Central Ranges, Esperance, Little Sandy Desert, Carnarvon.

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 and main findings
- Field work complete.
- Data analysis complete.
- Final draft of manuscript undergoing external review.

Management implications
- Fox populations can compensate for reduced density by increasing litter size and juvenile survival. These factors need to be considered when undertaking baiting campaigns or in the development of biological control for foxes.

Future direction(s)
Address referees comments and return manuscript to journal for publication.

CALM 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 and main findings
- Supported development of cat trapping regime at Two Peoples Bay using small enclosures and leg-hold traps.
- Radio-tracking studies of subadult animals have continued, to measure survival and follow dispersal movements. No further dispersal movements by young were seen. No young were found dead, but an old adult female was taken by a carpet python in February.
- Ongoing study of *Treponema* infection in captive and wild populations in collaboration with Agriculture WA Animal Health labs.
- New Landscope Visa card grant project commenced, extending the investigation of oxalosis to the wild population. Urine samples are collected from wild potoroos for determination of glycolate and oxalate levels.
- Supported Murdoch University Honours student Jeremy Lee's study of haemoparasites found in high numbers in Gilbert's potoroos.
- Continued to refine captive management techniques and commenced revegetation of pens at Two Peoples Bay in collaboration with Albany TAFE class.
- Cross-fostering trial with Adelaide University has been terminated after all 3 young transferred have been lost.
- New cross-fostering trial proposed, using a long-nosed potoroo colony at Two Peoples Bay initially, then if successful, purpose-built facility proposed.
- Supported Denmark Environment Centre hair-tubing project extending further west towards the Margaret River area.
- Commenced assessment of the suitability of Bald Island, off Cheyne Beach, as a translocation site, using hair-arching and faecal analysis to assess the mammal fauna and its dependence on hypogeal fungi.
- Continued support of Gilbert's Potoroo Action Group educational and fundraising activities.

Management implications
- Recovery of Gilbert's Potoroo requires the assessment of a number of different strategies as rapidly as possible as the threat of loss of the population through a wildfire is real.

Future direction(s)
- Design new captive diet based on truffle analysis.
- Establish a long-nosed potoroo colony in Albany and commence new cross-fostering trial.
- Evaluate removal and hand-rearing of large pouch young from the wild as a means to obtain new, less

stress-prone captive animals.
- Assess 2 potential translocation sites (Bald Island and Mount Manypeaks)
- 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 artificial insemination techniques in long-nosed potoroos.

CALM 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-Chichester National Park 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 and main findings
- Ongoing telemetry of 2 pythons on the Burrup Peninsula under funding provided by Threatened Species Network with Nickol Bay Naturalist Club.
- Ongoing telemetry at Millstream-Chichester National Park.

Management implications
- Data collected will permit a revision of the taxonomic status and meristic characteristics of the Pilbara Olive Python with a possible change to its conservation status listing.

Future direction(s)
- Analysis and publication of telemetry data from several sites in the Pilbara.
- Final 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 to clarify distribution and conservation status of species.

CALM Region(s)
Pilbara, Mid West.

IBRA Region(s)
Pilbara, Gascoyne.

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 and main findings
- Translocation of captive stock to Favourite Island (total 130 skinks) appears to have been successful with recaptures of released animals and the capture of a neonate indicating breeding.
- Reports on progress of Lancelin Island Skink Recovery Team to Corporate Executive.

Management implications
- The establishment of a second wild population of the skink will greatly improve its conservation status
- Captive breeding research indicates that the species is long lived and can be bred easily in captivity.

Future direction(s)
- Monitoring of Favourite Island translocated population and Lancelin Island population in Nov and Dec 2004. No further releases of captive-bred skinks contemplated but a direct transfer of individuals from Lancelin Island may be undertaken in the future to provide more genetic diversity in the translocated population.
- Publication of results of captive breeding and translocation to Favourite Island.

CALM Region
Midwest.

IBRA Region
Geraldton Sandplains.

Breeding ecology and conservation of the Banded stilt
SPP # 1999/0013

Team members
J Lane (0.05), G Pearson, A Clarke; Total (0.05).

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 and main findings
- An aerial survey of 2 lakes in the Eastern Goldfields is proposed for June 2004, following heavy rains earlier in the year and subsequent sightings of adults and young.
- Report on previous breeding activity was not prepared, due to priority being given to other work.

Management implications
- Discovery of new nesting locations (lakes and/or islands) has implications for mining and other potentially disturbing activities, for establishment of a comprehensive, adequate and representative conservation reserve system in the goldfields, and for conservation of the Banded Stilt.

Future direction(s)
- Rainfall reports from the Eastern Goldfields (main breeding range of Banded stilt in WA) will continue to 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.

CALM Region
Goldfields.

IBRA Region(s)
Great Victoria Desert, Murchison.

Ground parrot recovery

SPP # 2000/0002

Team members
AH Burbidge (0.05), J Rolfe (0.02) B Barrett (1.0); Total (1.07).

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 and main findings
- All contemporary and historical records brought into a digital environment, and accuracy validated, for use in a GIS, to facilitate planning of specific management actions.
- In collaboration with regional staff, discussion paper concerning fire management at Waychinicup–Manypeaks presented at workshops on the South Coast.
- Obtained significant NHT funding.
- Recovery Plan developed.
- Protocol being developed for translocation.
- Major systematic survey conducted in Fitzgerald River National Park.
- Monitoring surveys carried out in Cape Arid National Park and at Waychinicup.
- Surveys conducted in collaboration with the Friends of the Western Ground Parrot.
- Numerous media releases and presentations to community groups and the public.

Management implications
- Improved basis for decision-making concerning management, especially in relation to fire, in major conservation reserves on the South Coast.

Future direction(s)
- Develop monitoring protocol.
- Analyse data from monitoring program.
- Finalize Recovery Plan.
- Implement Recovery Plan where funds permit (including monitoring and a trial translocation).

CALM 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 improve the uptake of Probaits by foxes so that there is no significant difference between Probaits and Dried meat baits.

Summary of progress and main findings
- Field uptake trials completed and report written.
- Non-target testing completed and manuscript published.
- Field longevity trials completed, data analysis complete, report completed.
- Field trials to determine the effectiveness of different binders and foxes' preferences for flavour enhancers completed.
- Field trials to compare uptake of standard dried meat baits with 'improved' Probaits completed, data analysis underway.

Management implications
- If the uptake of Probaits by foxes can be increased to match that of the dried meat bait, probaits can be used operationally in all Western Shield sites and thus significant savings can be made by the Department.

Future direction(s)
- Complete analysis of data collected during field trial.
- Complete manuscript on bait development work and submit it to journal for publication.

CALM 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), AA 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 CALM 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 and main findings
- Field work undertaken in Oct 2003.
- Detailed analysis of 30 yrs of spotlighting data undertaken using DISTANCE 3.5 software.
- Report prepared and distributed to CALM and Chevron Texaco Jan 2004.
- Input into the Department's submission on the Environmental, Social and Economic assessment of the proposed Gorgon gas field development.
- Supervision of a PhD project examining the social structure and genetics of boodies on Barrow Island (and other sites).

Management implications
- Provision of baseline information on mammal abundance, and presence / absence of introduced mammal species.

Future direction(s)
- Workshop between CALM and Chevron Texaco staff to determine future directions of monitoring program.
- Field work planned for Oct 2004.
- More detailed analysis of mammal trapping data.
- Survey of Middle and Boodie Islands.

CALM Region
Pilbara.

IBRA Region
Pilbara.

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

SPP # 2001/0002

Team member
D Pearson (0.3); Total (0.3).

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 and main findings
- Monitoring in July and November 2003 and March 2004. Trapping success very low due to very dry conditions.
- Surveys for further populations of Mulgaras and other threatened dasyurids failed to locate other viable populations.

Management implications
- Mulgaras show a strong negative response to low rainfall, but appear to have larger resident populations than sympatric rodents.

Future direction(s)
- Ongoing monitoring of Mulgara populations at Mt Keith. Survey of other possible study sites at Leinster.
- Honours student to examine diet using 4 yrs of collected pellets and invertebrate sampling to look at prey selectivity during drought.

CALM Region
Goldfields.

IBRA Region
Murchison.

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 and main findings
- Ongoing links with industry (BHP Billiton) and Murdoch University – successful ARC grant.
- Bibliography updated.
- Cape Arid National Park surveyed for Heath mice – none trapped.
- Historic trapping sites resurveyed in Fitzgerald RNP/Ravensthorpe area.
- Study sites at Lake Magenta Nature Reserve monitored four times and information on home range, refuge sites, reproduction, mortality and diet obtained.
- Ongoing collaborations with staff / students undertaking ecological work on heath mice in Victoria (Deakin University).

Management implications
- Causes of rarity better understood. Climatic conditions, particularly rainfall, probably a significant factor in the fluctuation of population abundances.

Future direction(s)
- Ongoing ecological studies: mark-recapture trapping, radiotelemetry, refuge sites, habitat requirements.
- Re-survey of Fitzgerald River National Park sites.
- Investigate population dynamics.
- Predictive modelling of occurrence.
- Survey of predicted sites of occurrence.

CALM 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 and main findings

- Development and field trial for a cost effective folding soft trap for Mala undertaken, Field trails has indicated that the trap is also effective on Rock Wallabies and Tammars.
- Survey within Dryandra Woodland for surviving colonies of Dalgytes undertaken. Top up release of Dalgytes undertaken autumn 2004, monitored using tail transmitters. Dalgytes appear to have established well.
- Boodie translocation carried out into Dryandra Woodland proper autumn 2003 and spring 2004, radio-tracking/ monitoring carried out. Boodies have fallen prey to wedge-tail eagles, pythons, foxes and a cat.
- Additional Mala and Merrnine, sourced from Peron, released into RTD enclosure; monitored by radio collars, significant level of predated by Wedge-tail eagles determined. No surviving Mernine in enclosure. Despite predation by Wedge-tail eagle, Mala persisting well.
- From July 2004 District responsible for enclosure monitoring and data base management, monitoring within the enclosure reduced to 4-monthly intervals
- District responsible for all non-experiment releases of RTD species.

Management implications

- Current level of Fox control within Dryandra Woodland may not be adequate for Boodie reintroductions, implication for other species within the Woodland unknown.

Future direction(s)

- Future work dependent on funding.
- Development of trapping techniques and protocols for monitoring Dalgytes outside RTD enclosure.
- Investigate methods of ameliorating fox predation on released boodies.
- During 2004, source additional Marl for top up release into RTD enclosure. Radio-tracking of Marl in the enclosures 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 2005. Development of trapping techniques and protocols for monitoring Marl outside RTD enclosure.
- Mala TP for Tutanning Nature Reserve to be completed and submitted by end 2004. Mala translocation carried out into Tutanning Nature Reserve and radio-tracking/monitoring carried out by spring 2005. Development of trapping techniques and protocols for monitoring mala outside RTD enclosure. Top up release of Mala by spring 2006 if required.
- Merrnine TP for Tutanning Nature Reserve to be completed and submitted by end 2005. Source additional Merrnine and translocation carried out into Tutanning Nature Reserve by spring 2005. Development of trapping techniques and protocols for monitoring merrnine outside RTD enclosure.
- During 2005 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.

CALM 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. CALM 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 optimise control.
- To examine baiting frequency required to provide long-term sustained effective control.

In addition to optimizing 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.

Summary of progress and main findings

Optimising Baiting Programs

- 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 earlier cat eradication programs on islands is equally efficacious in the control of feral cats in the arid interior. This evidence has been supported recently by highly effective toxic baiting campaigns for feral cats at the Gibson Desert Nature Reserve, Wanjarri Nature Reserve and in July 2003 on Lorna Glen. The high level of control of feral cats during these exercises suggests that further reductions in bait distribution are likely to be equally efficacious.
- Assessment of optimum baiting frequency of baiting programs has recently commenced. Efficacy of feral cat control from continued baiting programs and a comprehensive monitoring and investigation of the timing and extent of cat reinvasion into the baited site will demonstrate whether sustained long-term control can be achieved. Preliminary results suggest that reinvasion is progressive across the baited area. Therefore the opportunity exists for providing sustained protection for a core area over time with surrounding buffer zones. Detailed measurement of the extent, rate and timing of dispersal into a baited has recently commenced.

Assessing the Potential Impact of Baiting Programs on Non-target Species

- A number of non-target species are potentially at risk from feral cat baiting programs because they are capable of consuming the relatively small, moist bait. A desktop evaluation to assess the likely impact to non-target species and has broadly defined a range of species potentially at risk. Assessment of bait consumption by these species is being undertaken in both field and complementary laboratory trials.
- A series of trials are currently being conducted to establish whether 1080 dose rates can be reduced in feral cat baits. The first of this trial series establishes certain parameters (e.g. time to death) at the current 1080 dose rate (4.5 mg per bait), so that valid comparisons can be made between the dose rates.
- Encapsulation of the toxin may increase target specificity of the toxin by reducing exposure to the majority of potential bait consuming, non-target mammal species because these species are significantly smaller than feral cats and have different dentition. The inclusion of toxic tablets in baits

could be a practical vehicle for toxins that would be ingested by feral cats yet rejected by smaller mammals. Colleagues at DPI (Vic.) have determined that a capsule (4.7 mm diam.) is the maximum particle size reliably accepted by cats, within the feral cat bait medium. They have recently tested the ability of several eastern states non-target species to ingest capsules manually implanted in a bait and found that the pellet in baits was rejected. CALM researchers have focused attention on developing the technology to enable automatic insertion of spherical capsules into the baits during bait manufacture. This was accomplished this year and provides a significant breakthrough to the bait-toxin delivery system. Assessment of capsule acceptance/rejection by the range of local species potentially at risk from feral cat baiting programs has commenced this year.

Validation of Track Density Index as an Estimate of Relative Cat Abundance

- The primary objective of this program is to develop a statistically sound and efficient sampling design for detecting change in the abundance of feral cat populations. A technique that provides the capacity to efficiently and reliably estimate feral cat relative abundance is an essential prerequisite for the planning and implementation of clearly defined prescriptions for feral cat control. Department researchers have previously employed a track density index to monitor feral cat relative abundance in projects on Peron Peninsula and the Gibson Desert. Trials have commenced to assess the accuracy of this technique to measure relative feral cat abundance.

Management implications

- Research into the development of baiting strategies to provide sustained and effective feral cat control over time will extend operational introduced predator control and wildlife reintroductions to the arid and semi-arid interior.

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 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.

CALM 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 CALM 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 IBRA Regions.

Native earthworms (Oligochaeta) of the Swan Coastal Plain: biodiversity, distribution and threatening processes

SPP # to be allocated

Team members

I Abbott (0.01) A Mellican (0.02) A Wills (0.15) T Burbidge (0.05) Total (0.28).

Aim

- To document the terrestrial Oligochaete fauna of the entire Swan Coastal Plain.
- To identify species with restricted ranges which are possibly vulnerable to threatening processes.
- To evaluate the adequacy of the system of formal and informal conservation areas for terrestrial Oligocheate conservation.

Summary of progress and main findings
Sample sites selected in June 2004.

Management implications
Better conservation of earthworm fauna and hence ecological processes on the Swan Coastal Plain.

Future direction(s)
Sample collection to continue in winter 2005 and 2006.

CALM Region(s)
Swan, SouthWest.

IBRA Region(s)
Swan Coastal Plain.

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 advice to enable the effective utilization of *Acacia* for nature conservation and applied purposes.

Summary of progress and main findings
- SPP for this project completed.
- AcaciaSearch report completed was published by RIRDC in 2004. 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 on-going (as basis for re-assessment of conservation status of the WA taxa).

Management implications
- Identification of *Acacia* species with agroforestry potential that facilitate conservation.

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.
- Undertake field work in Victoria to complete taxonomic revision of *Acacia verniciflua* work (with D Murphy, Melbourne University).

CALM 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 and main findings

- Current holdings in the Pilbara Regional Herbarium are 10 200 vouchers.
- Incorporation of over 1 800 additional vouchers in past 12 months.
- 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.
- Advice provided to Hamersley Iron on identification on over 500 voucher specimens.
- Reference collection of 1 600 vouchers was augmented through the addition of 400 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 Pilbara biological survey, 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 member

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 and main findings

- 151 vouchers of Declared Rare Flora confirmed or re-identified.
- 284 vouchers of Priority taxa confirmed or re-identified.

Management implications

- Improved flora conservation.

Future direction(s)
- Continue working on backlog of 77 Declared Rare and 127 Priority specimens.
- Identify and report on specimens brought in by Nature Protection Operations as required.

CALM 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 and main findings
- Obtained funding from NHT in 2003/004 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*.
- Published the paper 'Phosphite reduces disease extension of a *Phytophthora cinnamomi* front in *Banksia* woodland, even after fire' in *Australasian Plant Pathology.*

Management implications
- Effective methods of *P. cinnamomi* control using phosphite.

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.

CALM 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 and main findings
- Major new checklist of W.A. weeds published in Plant Protection Quarterly.

Management implications
- Assists in prioritizing management of weeds at a local, State and federal level.
- Provide input into CALM training workshops on weeds.

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.

CALM 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 (0.3), D Coates (0.3), B Macdonald (0.4); Total (1.0).

Aim
To provide genetic information for the conservation and management of Western Australian flora, especially rare flora, in particular to resolve the possible hybrid status of *Grevillea phanerophleba*; to determine the genetic structure within the new species Genus sp. Yalgoo; to determine the genetic diversity between the 2 subspecies of *G. curviloba* to inform taxonomic status; and to determine the taxonomic status of species in the *E. angustissima* complex.

Summary of progress and main findings
- *G. phanerophleba* – analysis of genetic variation of plants of *G. phanerophleba* and the putative parents *G. amplexans* and *G. biternata* from 2 locations has been completed. Comparison of the genetic identity and taxonomic identity is being carried out.
- Genus sp. Yalgoo - the genetic structure within this new species has been investigated with AFLP markers showing that the population at Gossan Hill is not genetically differentiated from the main populations, but the population farthest south is genetically differentiated.
- *Grevillea curviloba* – investigation of genetic diversity within and between the 2 subspecies has shown that they both have extensive clonality in some populations. There is some differentiation between the subspecies but this is confounded by the level of clonality within the populations. Differentiation from outgroups is still being assessed.
- *E. angustissima* – genetic diversity and differentiation of species in the complex has been published.

Management implications
- Assessment of the hybrid status of *G. phanerophleba* will ensure that management of this Critically Endangered species is appropriate.
- Knowledge of the genetic structure of Genus sp. Yalgoo means that informed decisions can be made in regard to mining proposals that impact on the populations.
- Clarification of the taxonomic status of the subspecies of *G. curviloba* will ensure appropriate management, and determination of the extent of clonality will enable correct DRF status to be assigned.

Future direction(s)
- Work on *G. phanerophleba* will be completed to resolve its putative hybrid status.
- Work on *G. curviloba* will be continued to resolve the level of differentiation between the subspecies and the extent of clonality within the populations.
- Analysis of *E. bennettiae* as a hybrid between *E. sporadica* and *E. lehmannii* will be published.
- Taxonomic revision of the leafless *Tetratheca* species in the Koolyanobing area will be published.
- The genetic structure within collections of *Synaphea* from the Pinjarrah Plains will be assessed to inform taxonomic revision and determine identity of questionable populations of the DRF taxa.

CALM Region(s)
South Coast, Midwest, Swan, Wheatbelt, Goldfields.

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 and main findings
- Significant data for inclusion in WATTLE assembled through the AcaciaSearch project; results of this project were published as a book by RIRDC in 2004.
- Stabilization of the name *Acacia* being sought through a formal proposal to retypify *Acacia* with an Australian type: paper published in international journal *Taxon* and Committee for Spermatophyta has voted in favour of the proposal (Committee's decision still requires ratification).

Management implications
- Improved ability to identify *Acacia* species.

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.

CALM 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 collect 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 and main findings

- Seed collections from more than 150 rare, threatened and poorly known taxa were made (197 accessions). This included 96 DRF, 93 Priority and 8 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 Seed Morphology Master Workshop in Perth (25-27 February, 2004).
- TFSC staff attended a Seed Ecology conference in Greece (29 April-4 May 2004)
- Completion of Phase 1 of international collaboration with the Millennium Seed Bank Project, UK.
- In conjunction with the CALM Albany District Conservation Officer, a bushbook on Endemic Flora of the Stirling Ranges National Park has been compiled. This book should be printed and available for sale by spring 2004.
- A project to investigate seedbank dynamics and response to disturbance of the critically endangered *Dryandra ionthocarpa* has been completed (June 2004) with Bankwest *Landscope* Visa Conservation Card funds.
- A paper was presented to the conference *Seed Eoclogy 2004* in Rhodes, Greece 29 April-4 May 2004, entitled 'Seed and seedling ecology of 3 rare endemics from Western Australia: important factors in the management of threatened species' by S Barrett and A Cochrane.
- Three book chapters were published:
  - Cochrane, A. 2004. Western Australia's *Ex Situ* Program: A Model Integrated Strategy for Conservation. *In* Guerrant, E. O., Havens, K. and Maunder, M. Eds. (2004) *Saving the Pieces: The value, limits and practice of off-site plant conservation in support of wild diversity*. Island Press.
  - Crawford, A., Cochrane, A. and Probert, R. 2004. Acid scarification: An effective method of increasing the speed and synchrony of germination in 5 Western Australian *Acacia* (Mimosaceae) species. *In* Smith, R.D., Dickie, J.B., Linington, S.H., Pritchard, H.W. and Probert, R.J. Eds (2004) *Seed Conservation: Turning Science into Practice.* Royal Botanic Gardens Kew, UK.
  - Cunneen, S. and Cochrane, A. 2004. The alleviation of dormancy in the horticulturally important *Chamelaucium uncinatum* (Myrtaceae). *In* Smith, R.D., Dickie, J.B., Linington, S.H., Pritchard, H.W. and Probert, R.J. Eds (2004) *Seed Conservation: Turning Science into Practice.* Royal Botanic Gardens Kew, UK.

Management implications

- Improved conservation of threatened plant taxa.

Future direction(s)
- Ongoing collection of seed for incorporation into the gene bank, 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.
- Commencement of Phase 2 of international collaboration with Millennium Seed Bank Project, UK will see increased seed collection targets and initiation of science research collaboration, including PhD by Andrew Crawford.
- Reporting requirements to NHT2 and MSB Kew.
- Articles for publication.
- Collaborative work with CALM Narrogin Nursery on seed germination requirements.

CALM 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 and main findings
- Tested 75 taxa for susceptibility in 2004.
- To date 50+ taxa transferred to pots for testing in 2005.
- Database of 200 + taxa updated.
- Provisional susceptibility list distributed within CALM.
- Published a paper 'Quantification of the susceptibility of the native flora of the South-West Botanical Province, Western Australia to *Phytophthora cinnamomi* ', in the *Australian Journal of Botany.*

Management implications
- Quantification of the threat of *P. cinnamomi* to flora conservation.
- Identifies flora at risk of infection.

Future direction(s)
- Plant up germinates as received from Threatened Species Seed unit throughout 2004/05.
- Inoculate plants in 2005 and record mortality.
- Update database.
- Test survivors for root infection.
- Test *Lambertia* species for within species variation in susceptibility.

CALM 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 member
S Patrick (0.2); Total (0.2).

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

Summary of progress and main findings
- Survey work has been undertaken in 3 CALM Regions.
- 27 taxa have been targeted for survey, with an increase of 30 known populations.
- 1 *Landscope* Expedition to the Midwest and Gascoyne Regions has furthered work on Priority taxa in those areas.

Management implications
- Improved knowledge of status and the need for listing threatened plant taxa.

Future direction(s)
- 6 taxa have been highlighted for recommendation for gazettal as rare after a small amount of further survey in the 2004 flowering season.
- Further survey is required on c. 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.

CALM 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 and main findings
- Published proceedings of the Dalwallinu Acacia Symposium (*Conservation Science Western Australia* 4(3): 1-191); author of 2 papers.
- Launched first stage of WorldWideWattle website in 2004. Site maintenance continuing.
- Dalwallinu Environmental Interpretive Centre concept was launched via webcast in 2004.

Management implications
- Greater understanding of *Acacia* conservation.

Future direction(s)
- WorldWideWattle: progress development of website through incorporation of additional content plus 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.

CALM 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 and main findings
- Paper published in *American Journal of Botany* on 'Evolutionary patterns and genetic structure in rare and widespread species in a triggerplant (*Stylidium caricifolium*: Stylidiaceae) species complex'.
- Paper in press in *Conservation Genetics* 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*'.
- Paper in preparation on ' Reduced genetic diversity and increased inbreeding in the rare ghost wattle, *Acacia sciophanes* compared with its sister species *Acacia anfractuosa*'

Management implications
- Prescriptions for the prevention of inbreeding and maintenance of genetic variation in small fragmented populations of rare and threatened plants
- Development of strategies for managing inbreeding and loss of genetics diversity during translocation programs

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.*
- Finalize paper on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis ssp. Fimbrilepis*'
- Complete temporal mating system data analysis on *B. cuneata.*
- Commence population genetic structure studies on the critically endangered *Verticordia staminosa*

CALM 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 and main findings
- 16 translocations planted in previous years were monitored.
- Assisted District CALM staff with planting and monitoring of new flora translocations for *Grevillea dryandroides* subsp. *dryandroides* and *Dryandra montana*.
- Set up one new translocation site for *Grevillea humifusa*.
- Development of flora translocation database continuing.
- Completed data scoring for mating systems study on *Lambertia orbifolia* translocation .
- Co-authored the revision of the Australian guidelines for threatened flora translocations. Guidelines published by Australian Network for Pant Conservation and launched June 2004.
- Study trip to the USA to visit flora translocation specialists in Oregon and Washington State, to discuss translocation techniques and theory and visit translocation sites. Trip partially funded by CALM June Craig Scholarship.
- Invited to assist in running two workshops on Australian threatened flora translocations in Sydney.

Management implications
- Improved conservation status for critically endangered plant taxa.

Future direction(s)
- Continued planting of experimental translocations of 21 critically endangered plant species where further planting's are deemed necessary.
- Continued monitoring of the 21 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.
- Assist in running at least two more interstate and one Western Australian workshop on threatened flora translocations.

CALM 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 and main findings
- Completion of analysis of site/population characteristics – disturbance and density.
- Completion of genetic variation studies covering all populations of *C. quadrifidis*, *E. wandoo* and E. pauciflora.
- Completion of microsatellite marker development for *C. quadrifidis* for gene flow studies and gene flow studies completed for 3 populations of E. wandoo.
- Completion of seed set/reproductive output analysis for years 1 and 2 for *C. quadrifidis* and *E. wandoo.*
- Commencement of growth/fitness trial experiments for *C. quadrifidis* and *E. wandoo*.
- Year 3 assessment of seed production in *E. pauciflora* commenced.
- Year 3 sampling for seed production and flowering phenology in *C. quadrifidus*, E. *wandoo* and E. pauciflora completed.
- Mating system studies completed for *E. pauciflora* and near completion for *E. wandoo* and *C. quadrifidis*
- Milestone report 2 submitted to Land and Water Australia.

Management implications
- Ability to rapidly and accurately assess the conservation value of a vegetation remnant is a critical step in landscape management aimed at integrating the goals of conservation and agricultural production. Currently much of this assessment is based on best guesses using anecdotal species-specific evidence, on the general principle that bigger is better (but at unknown cost in terms of 1 large site vs. many small sites tradeoffs) and on simple presence and absence data that take little account of long term remnant trajectories. The improved accuracy of assessment of long-term persistence of broad classes of plant species that this research provides will facilitate better prioritization of remnants for conservation and therefore better allocation of limited management effort.
- Establishment of realistic empirically based goals for remnant size and landscape configuration that maximize regional persistence of plants species will allow more efficient conservation efforts at the landscape level by facilitating cost-benefit analyses for remnant management and restoration work. That is, it is very useful to know when thresholds for viability have been reached so that limited management and restoration efforts can be redeployed to other areas where gains can be maximized.
- Identification of knowledge gaps in our ability to assess population viability and remnant vegetation value is crucial to improving future remnant management through targeted research efforts.

Future direction(s)
- Complete of analysis of site / population characteristics in relation to connectivity and isolation.
- Complete gene flow studies based on microsatellites for *E. pauciflora* and *C. quadrifidis.*
- Complete mating system studies on *E. wandoo* and *C. quadrifidis.*
- Completion of seed set / reproductive output analysis for year 3 for *C. quadrifidis* and *E. wandoo.*
- Completion of growth/fitness trial experiments for all 3 species.
- 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.

CALM 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 (0.4); Total (0.4).

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 and main findings
- 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.
- Treatments for 38 taxa have been completed.

Management implications
- A first meeting has taken place for the formation of a Recovery team for the 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 143 taxa remaining to be completed 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.

CALM Region
Goldfields.

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

The population ecology of Critically Endangered flora

SPP # 2000/15

Team Members
C Yates (0.8), R Fairman (0.5); Total (1.3).

Aim(s)
- Rank the ecological constraints to population growth in Declared Rare (Threatened) Flora and provide management guidelines for use in recovery plans;

- Determine whether there are differences in reproductive and ecological attributes between rare and common congeners, which explain why rare taxa are restricted in distribution and threatened.
- Provide general models of extinction vulnerability for plant functional groups (based on floral architecture, pollinator interactions and fire response)

Summary of progress and research findings
The reproductive and ecological attributes of the rare *Acacia lobulata* and *Acacia* sciophanes and their common relatives *A. verricula* and *A. sciophanes*.
- ML Buist PhD awarded. Rare and common species pairs shared more similarities than differences in autecological characteristics.

Breeding system, pollination and demography in the rare Critically Endangered granite endemic shrub *Verticordia staminosa ssp*. *staminosa* in south-west Western Australia.
- Paper published in *Austral Ecology*.
- Completed population viability analyses.
- Environmental history, particularly increased aridity and its interaction with fire are more important than reproductive biology and autecological factors for explaining the restriction of this shrub to 1 granite outcrop. Under current conditions the population is projected to remain stable or increase in size, but the effects of fire and climate change should continue to be monitored.

The relative importance of reproductive biology and establishment ecology for the persistence of a rare shrub *Verticordia fimbrilepis* ssp. *fimbrilepis*.
- Paper in press in *Conservation Biology.* Factors affecting seed germination and seedling establishment are more important than factors affecting seed production for the persistence of *V. fimbrilepis* in habitat fragments.

The fire ecology of the Eastern Stirling Range Montane Heath and Thicket community – A Critically Endangered Ecological Community.
- Monitored demography of DRF and other taxa of conservation significance.
- Monitored plant species richness and abundance in fire ecology quadrats.

Landscape Fragmentation and Rare Plant Species: Can We Develop a General Framework of Population Responses? ARC Linkage project with A Franks (PhD candidate) and R Hobbs, Murdoch University.
- Defined and allocated DRF to floral architecture functional groups.
- Surveyed insect pollinator communities across range of habitat fragments.
- Measured rates of pollination and reproductive output on selected plant species across habitat fragments.

Impacts of ecosystem fragmentation on plant populations: Generalizing the idiosyncratic
- Turner Review published in *Australian Journal of Botany*.
- Gained funding with R Hobbs and K. Maher from Land and Water Australia for PhD study Fire fragmentation and mammals, synergistic impacts on ecosystem dynamics.

Ecological factors constraining population growth in the Critically Endangered *Calytrix breviseta* ssp. *breviseta*.
- Collected demographic data.

The fire ecology and dynamics of a seasonally inundated heath on the eastern Swan Coastal Plain
- Collected data from monitoring plots.

Fire and the population dynamics of a critically endangered shrub *Cyphanthera odgersii* (F. Muell.) *haegi* subspecies *occidentalis haegi* (Solanaceae)
- Re-surveyed the *Cyphanthera odgersii* ssp. *occidentalis* experimental plots burnt in 1999.

Management implications

- Under current conditions the *Verticordia staminosa* ssp. *staminosa* population is stable. The persistence of reproductive adult plants has the greatest impact on population stability. Management should focus on minimizing factors that will cause adult mortality. These include accidental destruction, grazing by livestock and fire. Plants are killed by fire, but the granite habitat provides some protection and it is unlikely the whole population would burn. Predicted increased aridity associated with climate change may also result in the population declining.
- Prescribed fire will be needed to maintain populations of *Verticordia fimbrilepis* ssp. *fimbrilepis* and *Cyphantehra odgersii* ssp. *occidentalis* in habitat fragments.

Future direction(s)

- Submit paper describing the results of PVA modelling for *V. staminosa* for publication in refereed journal.
- Model influence of fire and rainfall on population viability of *V. fimbrilepis* in habitat fragments.
- Continue to monitor the Fire Ecology of the Eastern Stirling Range Montane Heath and Thicket Community. Begin preliminary analyses of data.
- Continue to co-supervise A Franks and Landscape Fragmentation and Rare Plant Species: Can We Develop a General Framework of Population Responses? ARC Linkage project.
- Submit paper describing pollination functional groups for publication in a refereed journal.
- Continue to monitor demography of *Calytrix breviseta* ssp. *breviseta* and dynamics of the seasonally inundated heath community that the taxon occurs in.
- Submit paper describing the *Cyphanthera odgersii* subspecies *occidentalis* research.
- Begin research on population ecology and viability of 4 narrowly endemic and threatened *Tetratheca* species.

DCLM Region(s)

Mid-west, Wheatbelt, South west, South Coast, Goldfields.

IBRA Region(s)

Geraldton Sandplains, Avon Wheatbelt, Jarrah Forest, Esperance, Coolgardie.

FORESTS AND TREE CROPS GROUP

A/Group Managers: Dr Lachlan McCaw and Dr Margaret Byrne

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 and main findings
- Major statistical and data management support for the FORESTCHECK project.
- Substantial statistical support to K Roy-Chowdrey (Wheatbelt Region), M Harding (Wildlife Branch), various staff in the Revegetation Systems Unit (Nature Conservation Division), P Van Heurck, N McKenzie (BCG) R Robinson, K Whitford (FTCG).
- Four manuscripts (*Armillaria*, with R Robinson, soil disturbance with K Whitford, and 2 papers on Karri site type 10, with G Wardell-Johnson) in press or in review.
- External consultancies to Forest Products Commission.
- Gave presentation at FORESTCHECK meeting, July 2003.

Management implications
- Consultation by operations staff with the biometrics unit, and our input into the design of experiments/monitoring projects/surveys provides a sound statistical basis to underpin management decisions.

Future direction(s)
- Increased support of CALM regional staff, particularly Regional Ecologists.
- Major analysis of FORESTCHECK dataset planned for 2006.

ENVIRONMENTAL SERVICES

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 captured in the DRJ clones of *Eucalyptus marginata* and the selections of *E. cladocalyx*; and investigate the genetic risk associated with agroforestry plantings.

Summary of progress and main findings
- *Acacia microbotrya* – Several taxonomic and genetic entities have been identified within this taxon which will lead to taxonomic revision. Analysis of populations in the overlap zone between what is currently recognized as var. *microbotrya* and var. *borealis* shows they are mixed populations with some hybridization occurring.

- *A. saligna* – Analysis with RFLP markers have identified 3 genetic clusters within this species complex which are divergent enough to warrant recognition at species rank in a taxonomic revision.
- *Pinus pinaster* – Microstatellite primers have been developed as part of an International Consortium.
- *Eucalyptus cladocalyx* – The genetic identity of provenance variation has been determined and selections are being assayed to determine their provenance of origin.
- *E. marginata* – 100 DRJ clones have been assayed. Analysis is being carried out to compare the diversity captured in these clones with that present in the natural populations.
- *E. occidentalis* - The level of outcrossing in a trial has been investigated with microsatellite markers. A very high level of outcrossing was found in all plants assayed.
- Environmental risk- Project with CRC salinity commenced to develop environmental risk assessment of new germplasm being developed for salinity plantings.
- Reports and journal papers have been written for *Melaleuca uncinata*, *Eucalyptus angustissima*, *E. occidentalis and E. marginata*.

Management implications
- *Acacia*- Several genetic and evolutionary lineages have been identified in both *A. microbotrya* and *A. saligna*. The level of differentiation between the lineages will support and inform taxonomic revisions of these 2 complexes. Clarification of the taxa within these complexes will enable development for revegetation plantings to be carried out in a reliable manor.
- *E. marginata* - Knowledge of the diversity captured in the DRJ clones compared to natural variation will ensure appropriate deployment of the clones for forest rehabilitation.
- *E. occidentalis* - The high level of outcrossing identified in the trial means that gene flow is effective and pollination activity is high even though the trial is planted outside the natural range of the species.
- Environmental risk- Knowledge of gene flow will enable informed assessment of genetic risk and development of management guidelines to prevent contamination of natural vegetation where necessary.

Future direction(s)
- Reports and journal papers will be written for *A. microbotrya*, *E. cladocalyx* and *E. marginata*.
- Laboratory work will be commenced on mating systems and gene flow in the *Eucalyptus angustissima* complex, *E. kochii* and *E. marginata*.
- Complete analysis on *E. marginata* DRJ clones.

CALM 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.

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

SPP # 99/08

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

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 and main findings
- 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.
- The capability of the tree-growth model CABALA was demonstrated to industry partners.
- Work has continued on a more user-friendly interface for CABALA plantation growth model.

Management implications
- Results to date show that it is possible to balance tree growth with the risk of drought death by using nitrogen application and by varying stand density.

Future direction(s)
- Workshop with plantation industry partners June 2004 for feedback on model development.
- Final measurement of tree growth in spring at all sites.
- Further development of the model CABALA.
- Development of look-up tables for assessment of site yield potential and risk.
- Project due for completion Sep 2004.

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

IBRA Region(s)
Jarrah Forest, Warren, 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 and main findings
- 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.

Management implications
- Although an outbreak of GLS has occurred only once in the history of jarrah forest management, this insect has the potential to increase in population to 110 larvae per kg dry weight of host foliage or more. This can cause serious defoliation in the jarrah forest. Two consecutive warm winters can induce a 2-generation per year population which contributes to a rapid population increase and thus a potential for population outbreak.

Future direction(s)
- Prepare an internal report to enable finalization of the project. This achievement has been given low priority.

- To incorporate findings from this study into the development of a forest health monitoring program.

CALM 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 and main findings
- Manuscript Title: Spatial analysis of *Uraba lugens* Walker (Lepidoptera: Noctuidae) outbreak in the southwest of Western Australia: Does logging, vegetation type or fire influence outbreaks? *Australian Forestry*, in press.

Management implications
- Past forest management practices have not influenced GLS populations. This research shows that jarrah grown in marginal areas (subject to drought and waterlogging) are more prone to severe defoliation and may act as the epicentre for GLS population outbreak expansion.

Future direction(s)
None, project completed.

CALM 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 on *Eucalyptus occidentalis*.

Summary of progress and main findings
- Fieldwork completed.
- Data validated and analysed. Life tables for 1989-1993, incorporating 14 generations, completed.
- Manuscript near completion.
- Resistant trees support oviposition but psyllids do not survive past the 3rd instar.
- This psyllid is now a cyclic outbreaker on its preferred host (i.e. its population regularly cycles from

outbreak to decline).

Management implications
- Use of resistant trees for reclamation of salt affected lands will help break the outbreak cycle and help improve the integrity of vegetation in these areas.

Future direction(s)
- Submit manuscript to journal (*Australian Journal of Entomology*).

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

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

Pest incursion of *Cardiaspina fiscella* in WA

SPP # to be allocated

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

Management implications
- To be aware of the potential of this insect to include Karri as a host tree.

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. This has been given low priority and is yet to be completed

CALM 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), R Hill (0.5); 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 CALM shall monitor and report on the status and effectiveness of silvicultural measures in the IRZ to protect water quality.

Summary of progress and main findings

- Post-silvicultural treatment, post-silvicultural burn changes in overstorey density were assessed from measurements of crown cover, crown density index, basal area and stocking in late spring-early summer 2003.
- Monitoring of groundwater levels, stream flow, stream salinity and stream turbidity in the 2 treatment catchments and in the control catchment has continued throughout the year.
- The effect of the treatments on groundwater levels has only become apparent 3 yrs after the harvesting and silvicultural treatments and 1 yr after the silvicultural burn. There was an average rise in groundwater levels between 0.33 m and 0.36 m in the hill slopes and valleys of the intensive treatment catchment, relative to the control catchment. In the standard treatment catchment there was a smaller response ranging from a rise of 0.12 m in the hill slopes to a fall of 0.12 m in the valleys relative to the control catchment.

Management implications

- The results should be interpreted after groundwater levels and stream salinities have reached their peak and this may occur 4 to 5 yrs after treatment.

Future direction(s)

- Continue monitoring of groundwater levels, stream flow, stream salinity, stream turbidity and rainfall for at least 2 yrs.
- Apply WEC-C hydrological model to post-treatment data of both treatment catchments to assess its suitability for simulating hydrological responses to the treatments.
- Use WEC-C to simulate hydrological responses to alternative timber harvesting and silvicultural treatments, and to different climate patterns.

CALM 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 (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 and main findings

- 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.
- Samples were collected from 3 low intensity prescribed fires in south-west forests over the 2002/03 season. A further 3 samples from silviculture and fuel reduction burns were achieved before the end of December 2003. The results from this sampling were combined with samples from the other States and have been incorporated in a project report by CSIRO Division of Atmospheric Research.

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Management implications

- Unknown at this stage.

Future direction(s)
No further work anticipated.

CALM 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 (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 and main findings

- No measurements were undertaken during 2003/04.

Management implications

- This could impact on the treatment of young Karri regrowth in the future.

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. The Warren Block experiment is to be continued with a view to further monitoring *Armillaria* infection in the different thinning regimes and its effect on growth rates.

CALM Region
Warren.

IBRA Region
Warren.

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

SPP # 97/03

Team members
L McCaw (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 overstorey and understorey structures.

Summary of progress and main findings
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.
- A project was implemented to test the application of fuel measurement system and fire behaviour findings from WA's Jarrah forest to eucalypt forest around Tumbarumba, NSW. One member of the team spent 2 weeks in Tumbarumba in February 2004, assisting with experimental set-up, fire behaviour measurements and post-burn assessment.

Management implications

- This will enable greater control over the results of prescribed burns and allow more flexibility in the use of fire in conservation.

Future direction(s)
The project has been completed and a report was 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.

CALM 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 and main findings

- No measurements were undertaken during 2003/04, and none are due until 2005.

Management implications

- The espacement of future Karri plantings are likely to be affected by the findings.

Future direction(s)
This project should be maintained as an important benchmark study with re-measurement scheduled on a 5 yearly 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.

CALM 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 and main findings
- Liaison with FPC on operational methods of control.
- Scientific paper published in Journal (Robinson, RM 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 published in journal (Robinson, RM, Williams, M and Smith, RH 2003 Incidence of *Armillaria* root disease in Karri regrowth forest is underestimated by surveys of above ground symptoms. *Australian Forestry* **66**: 273-278).
- Scientific paper in prep. (The effect of *Armillaria luteobubalina* on the growth and yield of Karri regrowth trees).

Management implications
- The control of *Armillaria* root disease has been integrated into first thinning operations in high quality Karri regrowth forest.

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

CALM 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 and main findings

- 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).
- Annual report completed.
- Book chapter published (Robinson, RM and Bougher, NL 2003. 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).
- Scientific paper in preparation (Robinson, RM, Mellican, A and Smith, RH. The succession of macrofungi following a wildfire in karri regrowth forests in Western Australia.)

Management implications

- Results contribute to information on the management of fire for maximizing biodiversity in karri forest.

Future direction(s)

- 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 other agencies with identification of voucher specimens.

CALM Region
Warren.

IBRA Region
Warren.

FORESTCHECK – Monitoring plant diversity in south-west forests

Core function

Team members
B Ward (0.3), R Cranfield (0.1); Total (0.4)
This project involves a number of staff from the Ecologically Sustainable Forest Management team, with assistance from staff at the WA Herbarium.

Aim
To monitor the effects of silvicultural practices on forest understorey vegetation species.
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 and main findings

- Fieldwork for 2003/04 completed and data checked and entered.
- A specific progress report on this project is available on the Science Division page of the CALM Web at: http://www.calm.wa.gov.au/science/science.html

Management implications

- FORESTCHECK is a long-term monitoring program and results will be used by Forest Managers to report against The Montreal Process criteria and indicators for Ecologically Sustainable Forest Management. FORESTCHECK has been incorporated in the Forest Management Plan 2004-13 as a strategy for increasing knowledge on the maintenance of biodiversity in WA's forests.

Future direction(s)

- Prepare and present 2004 Annual Report.

- Select and prepare grids for 2004-05 monitoring.
- Monitoring grids are to be established in the Eastern jarrah forest in 2004-5 financial year.
- Major analysis of data to be undertaken in 2006.

CALM Region
South West.

IBRA Region(s)
Jarrah Forest, 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 and main findings
- The third year's (2003) spring and (2004) 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 900 morphospecies have now been collected.

Management implications
- FORESTCHECK is a long-term monitoring program and results will be used by Forest Managers to report against The Montreal Process criteria and indicators for Ecologically Sustainable Forest Management. FORESTCHECK has been incorporated in the Forest Management Plan 2004-13 as a strategy for increasing knowledge on the maintenance of biodiversity in WA's forests.

Future direction(s)
The 2004 spring/autumn sampling will commence in Oct/Nov 2004.

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

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 and main findings
- Field work for 2002-03 completed and report presented and published in Annual Report.
- Field work for 2003-04 in progress.
- Results demonstrated that species richness was similar but species composition differed in jarrah forest

subjected to different logging treatments (Unlogged, Shelterwood, Gap Release). Species richness in the Warren and South West regions was similar but species composition differed significantly between the 2 regions.

Management implications

- FORESTCHECK is a long-term monitoring program and results will be used by Forest Managers to report against The Montreal Process criteria and indicators for Ecologically Sustainable Forest Management. FORESTCHECK has been incorporated in the Forest Management Plan 2004-13 as a strategy for increasing knowledge on the maintenance of biodiversity in WA's forests.

Future direction(s)

- Complete field work for 2003-04 monitoring.
- Prepare and present 2004 Annual report.
- Install grids and transects for 2004-05 monitoring.

CALM Region
Warren, South West, Swan.

IBRA Region
Jarrah Forest, Warren

FORESTCHECK - Vertebrate biodiversity study

Core function

Team members
G Liddelow (0.3); Total (0.3).

Aim
To monitor vertebrate (mammals, herpetofauna and avian fauna) biodiversity in the WA Jarrah forest in relation to silvicultural practices.

Summary of progress and main findings

- 2002-03 spring and autumn sampling is complete and has been databased.
- Report included in the FORESTCHECK Report of Progress 2002-3.
- 2003-04 sampling completed.
- The Western Shield fox-baiting program significantly affects the number of mammals recorded in jarrah forests in the Warren and South West regions.

Management implications

- FORESTCHECK is a long-term monitoring program and results will be used by Forest Managers to report against The Montreal Process criteria and indicators for Ecologically Sustainable Forest Management. FORESTCHECK has been incorporated in the Forest Management Plan 2004-13 as a strategy for increasing knowledge on the maintenance of biodiversity in WA's forests.

Future direction(s)

- Report 2003-04 in preparation.
- Sampling for 2004-05 to be carried out.

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

IBRA Region(s)
Jarrah Forest, Warren.

FORESTCHECK – Cryptogams (Lichens, Liverworts & Mosses)

Core function

Team members
R Cranfield (0.1) with assistance from Herbarium staff (0.01); Total (0.11).

Aim
To monitor and record cryptogam biodiversity in the Jarrah forest in relation to silviculture practices.

Summary of progress and main findings
- The second year's (2003) sampling has been completed and databased.
- Specimens sorted, processed and lodged in the Perth Herbarium.
- 490 samples collected (lichens, liverworts and mosses).

Management implications
- FORESTCHECK is a long-term monitoring program and results will be used by Forest Managers to report against The Montreal Process criteria and indicators for Ecologically Sustainable Forest Management. FORESTCHECK has been incorporated in the Forest Management Plan 2004-13 as a strategy for increasing knowledge on the maintenance of biodiversity in WA's forests.

Future direction(s)
- Sampling of the 2004 cryptogam season will commence in July 2004.

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

IBRA Region(s)
Jarrah Forest, Warren.

FORESTCHECK – Soil assessment

Core function

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

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 and main findings
- A third replicate of FORESTCHECK monitoring sites was established this year.
- Snig tracks and landings were successfully mapped on 3 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 faller's block disturbed by logging machinery, i.e. a measure of the extent of soil disturbance on the faller's blocks.
- 194 bulk density measurements were made on 2 new sites. These measurements provide information on the intensity of soil disturbance on these sites, and the size of the changes in bulk density caused by logging, relative to an undisturbed site.

Management implications
- Knowledge gained from the first years of FORESTCHECK soil disturbance monitoring was used to provide advice for the preparation of Forest Management Plan 2004-2013.

- The implementation of the requirements of Appendix 6 of Forest Management Plan 2004-2013 necessitated the development of guidelines for the assessment of soil disturbance in native forest harvesting. Development of these guidelines (*Assessment of soil disturbance in native forest harvesting*) made use of the knowledge and experience gained from FORESTCHECK soil monitoring.
- Field sampling techniques developed and tested in as part of the FORESTCHECK soil disturbance monitoring will be used in an adaptive management trial that is being set up by CALM and FPC to examine alternative approaches to managing soil disturbance to those proposed in the forest management plan.

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.
- Compile data and summaries for 5 yr report.
- Combine data from FORESTCHECK soil disturbance monitoring and proposed adaptive management trials of cording, and draft manuscript for publication.

CALM 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 CALM/FPC seed orchard for production of Pc-resistant Jarrah (NHT Project 003072 – 'Producing Dieback Resistant Jarrah for land and forest rehabilitation').

Summary of progress and main findings
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 16 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 2002-04.

Clonal DRJ Seed Orchard, CALM/FPC (NHT Project 003072):
- Infill planting was done in 2003 and 1 new line was added; the total number of unrelated DRJ lines planted is now 28.
- DRJ clones are now in production for Stage 3 (infill planting) in July 2004. Further production of clones will be required to reach the goal of 35 lines, and for infilling after losses (2005).

- First seed is expected to be produced within about 2 yrs.

Seedling inoculation trials (NHT Project 003072):
- A series of glasshouse inoculation trials was carried out in summer/autumn 2002-03, and monitoring carried on in 2003-04, 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 were done in April 2004.

Management implications
- 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 CALM managers, community groups and land holders for use in rehabilitation plantings of degraded forest and cleared sites. It will be possible to re-establish Jarrah on degraded sites where it has been mostly lost to dieback and on sites likely to become infested.

Future direction(s)
- Analyse data for 2002-04 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 2004 and 2005.
- 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.
- 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.

CALM 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 and main findings
Background
- Two large trials were established in 2003 at Willowdale and Jarrahdale, in collaboration with Alcoa and Perth Hills District staff, with first-year survival assessments now due.
- Planning is now in progress for the 2004 trials on black gravel DFR sites at Willowdale.

Management implications
- Site and seedling treatments giving best seedling survival will be applied to routine forest rehabilitation procedures for the re-establishment of Jarrah in degraded sites.

Future direction(s)
With the clonal DRJ Seed Orchard established, this SPP now incorporates trials of site preparation treatments for jarrah seedling establishment in forest sites [as opposed to minesites]. This develops the earlier work started by G Stoneman (SPP # 93/0094).

CALM 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 CALM (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 and main findings
- Low success rates were achieved in the first trials (2002) and these were compounded by problems with maintaining adequate watering in summer.
- The second set of trials (2003) were carried out at the FPC Wanneroo propagation centre with larger numbers of plants. Results are not yet available.

Management implications
- 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 to increase genetic diversity.

Future direction(s)
Application of grafting, if feasible, for the nursery propagation of Dieback-Resistant Jarrah.

CALM Region
Swan.

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

Mundulla Yellows disease in Western Australia

SPP # to be allocated

Team member
M Stukely (0.28): Total (0.28).

Aim
- To monitor Mundulla Yellows (MY) disease occurrence and spread in Western Australia.
- To conduct trials to investigate mechanisms of spread and conditions contributing to the development of MY (ARC Linkage Project).

Summary of progress and main findings
Background

- MY is a lethal disease of eucalypts that appears to be well established in various disturbed sites in WA (and other states). Its cause is unknown, but there is evidence that a virus or similar organism(s) is involved. Priority research includes determining the cause(s) of MY, its mechanisms of spread and the development of a rapid diagnostic test.

Progress

- Monitoring of MY in WA by CALM has continued, in collaboration with Dr D Hanold and Prof J Randles (University of Adelaide). The transects established in 2002 have been assessed. Several reports of possible MY-affected trees have been received from CALM staff.
- An ARC Linkage Grant, with CALM as an Industry Partner, commenced in March 2004 – 'A comparative study of the distribution and spread of potential molecular markers for Mundulla Yellows disease.'
- MY symptoms have been recorded in WA in remnant *Eucalyptus marginata, E. todtiana, E. rudis, E. camaldulensis, E. salmonophloia, E. loxophleba* and *Corymbia calophylla*; in planted *E. camaldulensis, E. gomphocephala, E. conferruminata, E. platypus, E. salubris, E. occidentalis, C. calophylla* 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. rudis*, *E. salubris*, *E. salmonophloia*, *E. loxophleba, E. gomphocephala* and *Corymbia calophylla.*
- M Stukely has been appointed to represent CALM and WA on the national Mundulla Yellows Task Group (MYTG) that submitted its final report in May 2004 to the Natural Resource Policies and Programs Committee (NRPPC) [formerly the LWBC] of the Natural Resource Management Ministerial Council. I have attended all formal meetings of the MYTG, including a Risk Management Workshop in May 2003, and have made a significant contribution to the preparation of its reports.

Management implications

- MY has the potential to cause enormous environmental damage if it progresses unchecked. Both remnant and planted trees can be affected. Once its cause, mechanisms of spread and contributing factors are known, management strategies can be developed to control the disease and prevent its spread to new areas.

Future direction(s)

- Continued monitoring of existing and new occurrences of MY in WA.
- Further education of CALM and FPC staff in relevant areas in identifying and reporting possible MY symptoms.
- Continued collaboration with, and assistance to, Dr Hanold.
- Additional field transects are to be established in WA for monitoring spread of MY from known infections to healthy vegetation.
- Trials to be carried out 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.

CALM 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.

Nutys Wilderness post wildfire monitoring

SPP # to be allocated

Team members
B Ward (0.05), G Liddelow (0.1), R Cranfield (0.05) P Van Heurck (0.1) L McCaw (0.05), R Smith (0.05)

Frankland District Staff as required; Total (0.4).

Aim
To monitor impact of severe wildfire on plants, invertebrates, vertebrate fauna and stand structure.

Summary of progress and main findings
- Data collection 2003 completed for plants, mammals, reptiles, amphibians and stand structure.
- Data collection for birds and invertebrates completed for 2003 and 2004.

Management implications
- Appropriate fire regimes for the conservation for the flora and fauna diversity in wilderness areas.

Future direction(s)
- Complete monitoring of plants and stand structure, mammals, reptiles and amphibians for 2004.
- Review monitoring program after 2006 sampling.

CALM Region
Warren.

IBRA Region
Jarrah Forest.

Quokka survey of the south-west forests
SPP # to be allocated

Team Members
G Liddelow (0.1) and regional staff as required.

Aim
- To survey quokka activity and distribution within the southern forest.
- To map quokka distribution.
- To provide management guidelines for district/region fire management plans.

Summary of progress and main findings
- Approximately 1300 sites across the southern forest have been identified.
- Mapping of sites is in progress.
- Analysis of activity results is in progress.
- Guidelines for fire management plans have been distributed for implementation.

Management implications
- Use of guidelines for fire management plans.

Future Direction(s)
- Complete analysis of southern forests survey.
- Extend survey to the northern forests.
- Publish findings.

CALM Region(s)
Warren, South West Swan.

IBRA Region(s)
Jarrah Forest, Warren.

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

Compare survey methods to identify the most effective means of detecting ngwayir and koomal.

- Describe the life histories of ngwayir and koomal within the Perup Jarrah forest (population demographics, fertility and development).
- Examine the habitat selection and preferences of these possums within the Perup Jarrah forest.
- Investigate what factors explain the distribution and abundance of ngwayir and koomal within the southern Jarrah forest.

Summary of progress and main findings

- Field work and data analysis associated with the examination of the effectiveness of different survey methods has been completed. The preparation of a manuscript for publication has commenced.
- Life history data on 72 ngwayir and 87 koomal at the 'Orient' study site were collected between June 2002 and November 2003.
- The radio-telemetry associated with the habitat selection study at the 'Orient' study site in Chariup forest block, Perup has been completed. A total of 44 ngwayir and 29 koomal were radio-collared between May 2002 - Nov 2003. During 110 days of radio-tracking approximately 3 350 day fixes were recorded involving about 240 refuges. Seventy-five nights of radio-tracking produced about 2 000 nocturnal records involving more than 1 200 night locations. A total of 121 habitat plots have been sampled within the 30 ha core of the study area to compare with the habitat use data collected. During this time, a total of 30 ngwayir and 5 koomal mortality events (predominantly predation) were observed involving radio-collared animals. Field work at the Orient site was completed by the end of April 2004.
- As part of the Distribution and Abundance Study, 90 sites were selected primarily by logging history, fire history and landscape position. These sites were live-trapped for possums between July and September 2003 to derive a measure of abundance, resulting in a total of 228 koomal and 29 ngwayir captures. Scat surveys (Jan to Feb 2004) at these sites were also used to derive an alternative index of abundance, particularly for ngwayir. Habitat surveys at these sites to collect covariate data were completed by April 2004.

Management implications

- Development of improved survey methods for the koomal and, particularly, the ngwayir, which is both difficult to survey and a threatened species. The improved methods can be used for both monitoring purposes (e.g. Western Shield) and in gathering population information to assist future assessments on the conservation status of ngwayir.
- Provides important information for the refinement of guidelines and operations to protect and manage important habitat elements and possum populations within the Jarrah forest (e.g. silviculture, prescribed burning, etc.).
- Identify habitats and forest communities that are particularly important for ngwayir to aid in their protection and conservation management. This information will also help to identify other forest areas where knowledge is poor that can be assessed for potential ngwayir populations, or that may be suitable for future translocations.

Future direction(s):

- Foliar nutrient sampling and analyses to examine i) the differences between heavily browsed 'feed trees' and nonfeed trees ii) how leaf nutrients relate to possum distribution and abundances, are planned to be completed by July 2004
- Data entry associated with the Life History, Habitat Selection and Distribution and Abundance Studies will be completed before the datasets are crosschecked, validated and prepared for analysis. Most analyses and manuscripts are planned for completion by December 2004.

CALM 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).

Aims
- Develop a method of describing the dimensions of hollows used by fauna.
- Describe the range of hollow sizes used by hollow dependant species from the Jarrah forests.
- Establish the relationship between tree size and tree age for Jarrah and Marri trees.
- Determine what types of trees and crowns bear hollows in the Jarrah forest and where in the tree crowns these hollows occur.
- Examine the distributions of the sizes, shapes and orientations of these hollows.
- Determine the ages of trees bearing hollows.
- Determine if hollows can be reliably detected from the ground.
- Examine the relationship between tree and crown attributes and the abundance of hollows.
- Develop predictive relationships for hollow occurrence and provide descriptions of the type of trees most likely to bear hollows.
- 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.
- Identify fauna species most likely to be threatened by any future shortage of suitable hollows.
- Examine the occurrence of hollows suited to the species most at risk.
- Examine the relationship between logging history and the abundance of hollows and logs on the forest floor in various forest types.
- Examine the impact of log removal from the forest on the number and types of logs present on the forest floor and the number and types of hollows on the forest floor.
- Examine the relationship between burning history and the abundance of hollows and logs in various forest types.
- Examine the potential for modelling of recruitment, decay and removal of logs from the forest floor.
- Identify the types and sizes of log hollow that are likely to be used by hollow dependent fauna in the Jarrah forest.
- Determine the density of log hollows required by various hollow dependent fauna in the Jarrah forest.

Summary of progress and main findings
- 5 papers published from this research.
- One additional paper currently in press.
- *Landscope* article published.

Management implications
- This research contributed to knowledge of hollows and hollow use in standing trees in the Jarrah forest.
- Findings from this research were used to revise the silviculture guidelines for the Jarrah forest.

Future direction(s)
- Establish and measure plots in virgin Jarrah forest sites to extend the data on hollows and logs on the forest floor.

CALM 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 # to be allocated

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 and main findings
- The field work and data analysis is complete and the final report to the funding body has been submitted, reviewed and accepted.
- The final report was revised this year and has been published on the Forest and Wood Products Research and Development Corporation's website.
- Two manuscripts from this work have been submitted for internal review and require further revision.

Management implications
- Advice was provided during the preparation of Forest Management Plan 2004 - 2013.
- Advice was 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.
- Findings from this work were used in developing the guideline *Assessment of soil disturbance in native forest harvesting*.

Future direction(s)
- Revise and submit 2 manuscripts that have been prepared for publication.
- This SPP is no longer active and no future work is currently planned on this SPP.
- An adaptive management trial is currently being developed in conjunction with the Forest Products Commission and the timber industry to examine alternative approaches to managing soil disturbance to those proposed in the forest management plan. This builds on research conducted under this SPP. If this trial develops to a level that involves research staff and includes a research component then a separate SPP will be developed to cover this trial.

CALM 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 and main findings
- 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.

Management implications
- Results from this research were used in the current revision of the silvicultural guidelines – *Silvicultural Practice in the Jarrah Forest* – in the section on seed crop assessment and in the formulation of Appendix 4 on the calculation of capsule and seed crop. These results will also be used in the *Silvicultural Survey Procedures Manual.*

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.

CALM 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 and main findings
- 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 defoliation by fire or insects for extended periods.

Management implications
- Defoliation intensities and return frequencies under current fire management regimes do not appear to threaten the persistence of Jarrah saplings.
- Chronic defoliation due to insect pests, while having a detrimental effect on growth, is unlikely to affect the persistence of Jarrah saplings.

Future direction(s)
- Project completed.
- Paper submitted to *Australian Forestry*.

CALM 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 and main findings
- Site inspected, no maintenance required.

Management implications
- 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.

Future direction(s)
- Carry out coppice removal on treated areas as required.

CALM 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 and main findings
- Sorting of ants, beetles and spiders to morphospecies level completed and data entered into database.

Management implications
- Not yet apparent as analysis of data not completed.

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

CALM Region
Swan Region.

IBRA Region
Jarrah Forest.

BUGBASE: the database of the CALM conservation terrestrial invertebrate collection

Core Function

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

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

Summary of progress and main findings
- Data entry (funded by Gordon Reid Foundation for Conservation under administration of Lotterywest) is substantially complete with in excess of 15 000 records.
- BugBase can be accessed on the CALM Science Division web page:

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

Management implications

- Because BugBase is a terrestrial invertebrate collection database, the information contained within is essentially of a forest and farming nature i.e. the terrestrial invertebrates have been found on forest trees and farm trees including Blue Gums and Oil Mallees, but there are insects from wood and herbarium specimens sent in, or brought in, from the general public or from quarantine inspectors. As BugBase is a copy of the Agriculture Department Insect Collection Database (ICDB) the general public will be familiar with its use and can readily access information on native and introduced species. The project will manage the resource in much the same way that FloraBase does and the information available includes: Order, Family, Genus, Species, Subspecies, Type Status, Nearest place collected from, Australian State and Collector's name.

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 and main findings

- 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.

Management implications

- Restricted distributions of relatively immobile species such as earthworms are indicative of rapid spatial turnover of species across tens of kilometres. While there are large reserves near Albany, remnant vegetation on private property and along road verges may be critical for the survival of most of the native earthworm fauna. Samples from pastures around the Porongurup Range supported only 3 of the 17 native species found.

Future direction(s)

- Project completed. Paper has been published in the refereed journal *Biology and Fertility of Soils* (2003) **39**: 94-102.

CALM Region

South Coast.

IBRA Region

Jarrah Forest.

Vegetation Health Service

Core Function

Team members
M Stukely (0.25), J Webster (0.6); J Ciampini (0.4); Total (1.25).

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.
- To provide a service which is also available to external customers for a charge.
- 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 and main findings
- A total of 1251 samples were processed for *Phytophthora* between July 2003 and April 2004.
- 185 *Phytophthora* isolates (other than *P. cinnamomi*) were subcultured for identification to species.
- Several unusual *Phytophthora* isolates were sent to Murdoch University for DNA analysis.
- Advice and consultations concerning other plant diseases were given to various CALM staff and members of the public as required, including several Naturebase inquiries.

Management implications
- Accurate testing of samples for *Phytophthora* is an essential element of the Dieback Interpretation process for assessing the dieback status of a site and mapping areas affected by *Phytophthora* dieback. A wide range of management decisions for given areas are based on this information.
- Advice on other plant disease problems will assist in the management of these problems.

Future direction(s)
- 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 recently isolated *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.

CALM 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

ASTRONOMICAL OUTREACH AND 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), R. Tonello (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 and main findings

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. Development and marketing astronomy education resources.

Most of the milestones for these activities involved the maintenance of the level of activity and user participation. Activity 2 had the extra emphasis this year on the close apparition of the planet Mars. Extra star viewing nights and activities were conducted in order to meet the high public interest in this rare event.

A large increase in the number of night time visitors was largely due to the Mars viewing nights. The media excited the public of WA about this relatively rare event, and the public responded by wanting to view Mars at their local Observatory. The staffing required for this extra work has meant that other activities have had to be curtailed, and this is reflected in the other activities indicators such as day time guided tours, and publications.

Furthermore, 2 comets passed close by the Earth in May 2004 and had the potential to generate more public interest and the attendant viewing requests. They were closely monitored by the Observatory but neither became bright enough and no extra activities were required. The June 8 transit of Venus was well publicized, and there was great demand on the Internet for the live images from the Observatory Solar Telescope.

Activity Measures

Activity	2003/2004*	2002/2003	2001/2002
Star Viewing Nights	212	178	185
Night Visitors	7246	5653	6107
Daytime guided tours	79	146	122
Day visitors	2055	4119	3607
Astronomy Field Nights	18	23	27
Field Night attendance	1524	2496	2833
Lectures and Talks	44	82	89
Talk attendance	1126	1990	2899
Student consultations	18	86	57
Customer satisfaction (star viewing and guided tours)	-	94%	94%
Astronomy awareness raised	-	95%	95%
Educational quality	-	98%	96%

(*for 1 July 2003 to 31 May 2004)

Management implications

- The substantial increase in visitor numbers, together with sound customer satisfaction evaluations, indicates that there is continuing strong demand for these services from the Observatory. Furthermore, activities conducted in this project are reasonably well aligned with CALM's KRA's 5 and 6.

Future direction(s)

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

- Activity 1 - Investigate and develop a partnership with the Scitech Planetarium.
- Activity 2 - Further improvement of the PC presentation with updated software.
- Activity 3 - Develop and market astronomy education resources - creation of a new educational resource – teacher resource kit, and manual operation of Project Astronet (internet telescope).

ASTRONOMICAL INFORMATION SERVICES

Core function

Team members

J Biggs (0.2), P Birch (0.2), R Martin (0.1), A Verveer (0.1), J Bell (0.2), A Williams (0.1), J Pearse (0.1), R. Tonello (0.1), G Lowe (0.1), D Johns (0.2); Total (1.3).

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 and main findings

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.

Activity 1 has shown a large increase in the contacts made by Perth Observatory to the general public. This was mainly due to the close apparition of Mars, and 2 potentially bright comets. It was also increased by the automation of the telephone accounting system used to keep track of the number of telephone calls - computerized software tallied all the calls, whereas pressure of work had meant that many were not previously being recorded satisfactorily. The information line also mirrored this increased interest.

Activity 4 has shown a very large increase due to new services provided by the Observatory. A new initiative has been the establishment of the Observatory automated sky camera, which operates from the roof of Perth Observatory. This instrument, built in the observatory workshop, takes an image of the sky every 15 minutes, and sends it to our website where it can be accessed by the public. This has generated great interest in the community. It also has the added advantage of being accessible to the disabled who can actually see what is visible in the sky from their home. This project will be developed in the future as resources allow.

Activity 5 has involved the creation and display of 3 posters that highlight the Observatory, its volunteer program, and the transit of Venus.

Management implications

- The substantial increase in information service provision, together with sound customer satisfaction evaluations, indicates that there is continuing strong demand for these services from the Observatory. Furthermore, activities conducted in this project are reasonably well aligned with CALM's KRA 6.
- Continued demand will require the Observatory's Internet access to be significantly upgraded. There may be considerable customer complaints unless this infrastructure is updated to approach that provided by kindred institutions.

Future direction(s)

The activities and milestones remain essentially the same for 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 Measures

Activity	**2003/2004***	**2002/2003**	**2001/2002**
Telephone enquiries	18,033	9,872	11,138
Information line	3154	1,462	1,001
Email enquiries	491	562	535
No. talks, lectures etc	44	82	89
Talk attendance	1126	1,990	2,899
Consultations	32	86	57
Newspaper, radio & TV	130	136	149
www page hits	1,272,191	1,116,079	875,783
Positive responses to ‘quality’ question in customer surveys	-	98%	98%
Satisfaction of information requests as they occur	-	98%	99%

(*for 1 July 2003 to 31 May 2004)

ASTRONOMICAL 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 and main findings
Progress in individual projects is detailed below for each SPP. Observatory staff published 3 papers in refereed international journals and another 6 in minor publications (poster papers, abstracts etc). 100% of referred papers submitted were published (100% in 02/03).

Management implications
- There is ongoing external demand for scientific collaborations that exploit the Observatory's isolated location.
- Continued government support of the Observatory's scientific activity provides substantial evidence that it is serious in its endeavours to attract to the state the SKA, the world's largest radio telescope. Furthermore, such support is part of CALM's Corporate and Output priorities for 2004/2005 relating to KRA 6.

The details 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), R Tonello (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 and main findings
- No observations were made in 2003/2004 as there were no suitable targets bright enough for our instruments.
- One refereed paper was published concerning earlier work.

Future direction(s)
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'. No target stars have been announced for 2004/2005.

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), R Tonello (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 and main findings

- Several cometary observations were made in 2003/2004, however, due to shortage of staff, and pressure of other programs, available comets were not monitored fully.
  Observations made will be included in future publications with other cometary scientists.

Future direction(s)

- 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 2004 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), R Tonello (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 and main findings

In 2003 / 2004 follow up astrometry observations were conducted and promptly published in IAU Circulars for 2 supernovae discovered in SPP 98/0014. Also, possible transient changes to the star SS2883 were monitored in a student project.

Future direction(s)

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), R Tonello (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 and main findings

- In 2003/2004, a total of 78 (57 asteroid and 21 comet) minor body positions were published, staff shortages curtailed activity in this project
- Work proceeded on the integration of the telescope and camera control functions onto 1 PC.

Future direction(s)

Monitoring of NEOs will continue with the milestone an increased number of published positions. Further integration of telescope and camera control onto 1 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), R Tonello (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 and main findings

- Following the successful installation of the cloud detector and the scheduler, the number of PLANET observations has doubled in comparison to previous years.
- The telescope was used to contribute to the data gathering during the previous PLANET observing season, as well as staff contributing to the data reductions. Perth Observatory staff constructed the web pages for the PLANET site.
- Two refereed papers were published.

Future direction(s)

The June-August 2004 bulge season includes many prime events, several papers are being prepared, and one has been submitted.

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), R Tonello (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 and main findings

- Two new supernovae were discovered during the 2003/2004 year, and another 2 new supernovae were detected, but just after discovery by other astronomers.
- One set of photometric light curves was determined for SN 2004S and a paper is in preparation.
- 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. The student is currently writing his PhD thesis and we are currently still monitoring the Gamma Ray Bursts as they occur.

Future direction(s)

Paper concerning SN 2004S should be submitted for publication. Commissioning of an automated focuser for the PLAT should begin this year and facilitate an increased number of observations.

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), R Tonello (0.01); Total (0.16).

Aim

Testing appropriate Western Australian sites regarding their suitability for astronomical observations. This will provide information necessary for the planning of future facilities.

Summary of progress and main findings

- An observation run over several nights was undertaken on the summit of Mt Singleton.
- An additional set of observations was undertaken at various locations on the Perth Observatory site.
- These data were analysed during the course of a student project.

Future direction(s)

This site evaluation project will result in a paper detailing the preliminary results of conditions for optical astronomy observing in WA. Also, observations at other sites will be conducted as resources allow.

STUDENT PROJECTS – PROGRESS REPORT

The following reports were supplied.

Scientist: I Abbott
Student: T Simmons

Project title
Establishing bird community indices in the Jarrah forest of southwest Western Australia

Progress report
Having completed an initial summary of the date collected up until February 2003, another more in depth study was designed to be completed over the spring/summer period of 2003/2004. Four zones were established in the northern/central Jarrah forest from Armadale to southern Collie, with 10 impacts/ages to be assessed within each of the zones. Bird data collection was limited to days between 23 and 34^{o}C, while the other days were used to collect detailed vegetation analysis. This led to a total of 87 field days over the period, and a lot of extra bird surveys completed that will not be included in the analysis.

The 10 impacts looked at are as follows:

Impacts	**3 yrs since**	**5 yrs since**	**> 20 yrs since**
Fire	Yes	Yes	Yes
Logging	Yes	Yes	Yes
Mining	Yes	Yes	No
Dieback	No	No	Yes
Silviculture (pines)	No	No	Yes

Due to the fluctuating nature of the Jarrah forest it was decided that it was almost impossible to have a defined control for this study.

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 2003/04) the study was expanded from 4 to 21 sites of remnant bushland on the Swan Coastal Plain. 33 species of day-flying Lepidoptera (30 butterflies, 1 burnet and 2 sun-moths) have been identified in the surveys, including the threatened graceful sun moth (*Synemon gratiosa*), which has now been recorded at 5 sites, 3 of which are new records.

Scientist: I Abbott
Student: B Giltay

Project title
The relationship between soil mesofauna and land use

Thesis abstract
The abundance of mesofauna can be influenced by land use practices. The current study investigated the impact of 3 land uses on the abundance and diversity of mesofauna to 10 cm depth in the topsoil. Remnant vegetation, intensive cropping (horticulture) and grazing were compared. Abundance of mesofauna did not change with land use. Instead, land use which was associated with a particular level of disturbance determined the depth at which mesofauna were distributed in the topsoil. Mesofauna were more abundant in the upper topsoil in soil with the less disturbed land use and less abundant in the surface of the soil with highly disturbed land use.

Scientist: I Abbott
Student: D Paini

Project title
The impact of the European honey bee (*Apis mellifera*) on Australian native bees

Thesis abstract
The European honey bee (*Apis mellifera*) has been present in Australia for approximately 150 yrs. For the majority of that time it was assumed this species could only be of benefit to Australia's natural ecosystems. More recently however, researchers and conservationists have questioned this assumption. Honey bees are an introduced species and may be affecting native fauna and flora. In particular, native bees have been highlighted as an animal that may be experiencing competition from honey bees as they are of similar sizes and both species require nectar and pollen for their progeny. Most research to date has focused on indirect measures of competition between honey bees and native bees (resource overlap, visitation rates and resource harvesting).

Scientist: M Byrne
Student: E Dalmaris

Project title
Wandoo decline: ecophysiological and genetic variation among provenances

Progress report
Eucalyptus wandoo is an endemic specie of the SW of WA and is one of the main tree species of the vast wheatbelt. Over past decades Wandoo has suffered huge habitat losses due to the clearing of forest and woodlands for agricultural purposes. Now it is under the threat of crown decline.

Two trips to the region have been made and 30 populations have been chosen for the purposes of the research. The populations cover the Wandoo distribution and were mostly selected from populations inside National Parks and in areas without previous grazing and are from areas that were as natural as possible, with populations that covered different health status (healthy, intermediate health and unhealthy) and different rainfall (high, intermediate, low rainfall). From those populations:

- Wandoo fruit have been collected and seeds have been extracted to be used for the glasshouse experiments.
- Leaves have been collected and have been stored for genetic analysis.
- Foliar and soil material from Wandoo and other tree species has been sampled for chemical analysis.
- Health rating was conducted for all the trees that were chosen in each population.

The first experiment is in progress and it concerns screening the tolerance of Wandoo from the chosen populations in moderate level of salinity, using ecophysiological techniques (e.g. water potential measurements, gas exchange measurements).

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 and a high proportion of the described species are currently listed as either Priority or Rare.

Morphological and molecular characters have been used in cladistic analyses to test the infrageneric classification of *Synaphea* proposed by AS 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*. Morphometric investigation of species boundaries and infraspecific variation in 2 problematic species complexes with high conservation priority are ongoing.

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 saligna is native to south-western Australia, and is used widely around the world as a source of livestock feed. It has been proposed that *A. saligna* has the potential to be used in Australia more widely as a fodder crop for livestock feed where it will also assist with dryland salinity management. The aim of this project is to gather information about *A. saligna* that will facilitate its development as a crop plant.

The fodder quality of *A. saligna* has been investigated by analysis of over 400 trees from 20 natural populations using a combination of wet chemistry and Near Infrared Spectroscopy. Near Infrared Spectroscopy allows the rapid analysis of large numbers of samples. This will identify populations of *A. saligna* with superior fodder quality fodder that can be targeted for selection activities. Data from this work is currently being analysed.

The reproductive biology of *A. saligna* was examined during the last flowering season in spring. The study investigated the occurrence of female sterility, the timing of stigmatic receptivity in relation to floral opening, pollen vectors and methods of pollen storage. A number of interesting findings have come from this work, and they are guiding more detailed investigations that will be carried during the next flowering season this spring.

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: M Millar

Project title
An assessment of genetic risk to natural biodiversity from agroforestry revegetation

Progress report
Acacia saligna is a native woody perennial identified as warranting further commercial development for use in agroforestry. Wide-scale plantings of *A. saligna* as a perennial crop will produce environmental and economic benefits, however they may also pose risks to natural biodiversity in certain areas through invasiveness and gene flow via pollen. This project aims to make recommendations for use in assessing and minimizing the risk posed by *A. saligna* plantings due to invasiveness in South Australia and develop guidelines for determining suggested isolation distances between agroforestry plantings and natural populations in Western Australia. An *A. saligna* microsatellite library is being developed for use throughout the project in detecting and assessing levels and distances of gene flow. Planted trial sites with mixed provenance seed sources are being investigated for use in assessments of flowering phenology, hybridization and gene flow.

Scientist: M Byrne
Student: L Stone

Project title
Propagation of blue-flowered *Conospermum*

Progress report
The PhD study into the floral biology and propagation of blue-flowered species of *Conospermum* was completed in 2003. A survey of tissue types that may enable induction of somatic embryogenesis was carried out for 2 species of *Conospermum*. Results showed that vegetative and floral material was not suitable, however zygotic embryos rescued from mature seed was successfully used to induce somatic embryos. DNA analysis of these somatic embryos showed there was an unacceptably high level of

somaclonal variation. Maturation and germination of the somatic embryos proved difficult, and it was concluded that this method of propagation had limited potential in these species.

Controlled hand pollinations of *C. eatoniae* did not produce seed, whereas open pollinated seed was set. DNA analysis showed plants in a field station setting were more likely to self, whereas those in a wild population preferentially outcrossed. These results have implications for design of commercial plantations, but also have implications for the conservation management of the species.

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.

Scientists: 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: 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 ongoing.

The literature review was submitted to the Charles Sturt University in February 2004.

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.

19 populations of *E. pauciflora* have been 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 gene flow are being developed.
The first chapter of this thesis reviews previous research explaining that many experiments lack significant replication and indirect measures of competition cannot evaluate the impact of honey bees on native bee fecundity or survival. Chapters 2 and 4 present descriptions of nesting biology of the 2 native bee species studied (*Hylaeus alcyoneus* and an undescribed *Megachile* sp.). Data collected focused on native bee fecundity and included nesting season, progeny mass, number of progeny per nest, sex ratio and parasitoids. This information provided a picture of the nesting biology of these 2 species and assisted in determining the design of an appropriate experiment.

Chapters 3 and 5 present the results of 2 experiments investigating the impact of honey bees on these 2 species of native bees in the Northern Beekeepers Nature Reserve in Western Australia. Both experiments focused on the fecundity of these native bee species in response to honey bees and also had more replication than any other previous experiment in Australia of similar design. The first experiment (Chapter 3), over 2 seasons, investigated the impact of commercial honey bees on *Hylaeus alcyoneus*, a native solitary bee. The experiment was monitored every 3-4 wks (measurement interval). However, beekeepers did not agist hives on sites simultaneously so measurement intervals were initially treated separately using ANOVA. Results showed no impact of honey bees at any measurement interval and in some cases, poor power. Data from both seasons was combined in a Wilcoxon's sign test and showed that honey bees had a

negative impact on the number of nests completed by *H. alcyoneus*.

The second experiment (Chapter 5) investigated the impact of feral honey bees on an undescribed *Megachile* species. Hive honey bees were used to simulate feral levels of honey bees in a BACI (Before/After, Control/Impact) design experiment. There was no impact detected on any fecundity variables. The sensitivity of the experiment was calculated and in 3 fecundity variables (male and female progeny mass and the number of progeny per nest) the experiment was sensitive enough to detect 15-30% difference between control and impact sites.

The final chapter (Chapter 6) makes a number of research and management recommendations in light of the research findings.

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: S Halse
Student: W Kay

Project title
Population ecology of estuarine crocodiles, *Crocodylus porosus*, in the Kimberley region of Western Australia

Thesis abstract
The Western Australian population of *C. porosus* is poorly studied despite its history of hunting and commercial utilization. This study provided important demographic data that have changed the conventional view of estuarine crocodile biology.

Male and female radio-tracked crocodiles on the Ord River exhibited distinctly different patterns of movement. Females occupied a small core linear range (1.3 ± 0.9 km) on the main river channel during the dry season and moved distances of up to 62 km to nesting habitat during the wet season, returning to the same core area the following dry season. Males moved considerable distances throughout the year. The largest range recorded was 87 km for a 2.5 m juvenile male. However, male ranges did not appear to be related to body size, with the largest 2 ranges recorded for the smallest (2.5 m) and largest (4.3 m) males tagged. Rates of male movement did not differ significantly between 3 size classes of males. The highest rate of sustained movement was 9.8 km/d for a translocated 2.6 m juvenile male, which traveled 118 km in

12 days to return to the area of its capture. Males had substantial range overlaps with no obvious spatial partitioning suggesting territoriality is not an important behavioural characteristic of free-ranging male crocodiles along the Ord River.

Levels of genetic diversity were examined in 3 Kimberley populations at 9 microsatellite loci. Genetic diversity was similar in all 3 populations studied (Ord, King and Glenelg Rivers) with allelic richness ranging from 4.6 to 5.0 alleles per locus and mean observed heterozygosities ranging from 0.63 to 0.74. Inbreeding coefficients indicate there is only moderate differentiation among Kimberley populations (F_{ST} = 0.08, R_{ST} = 0.06). Assignment tests designated 80% of individuals to their population of origin and identified only 5 individuals (4%) as first generation migrants. Genetic data indicates *C. porosus* shows strong site fidelity and indirect estimates of migration rates from fixation indices suggest rates of about 3 individuals per generation.

A mark-recapture study on the King River showed the size of the hatchling population (age < 1 yr old) to be 91 ± 1.9 (SE) in 2001, which was effectively an estimate of successful recruitment for the King River during that year. The size of the non-hatchling population (age > 1 yr old) was estimated to be 69 ± 13.3 but the this estimate should be treated cautiously. Survival of the 2001 cohort of hatchlings was high (> 95%) between June and December and did not vary between the sexes. Crocodiles showed a significant behavioural response to capture, with capture probabilities decreasing when disturbance was high. This has important implications for monitoring of crocodile populations.

Publications to date

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Kay W. R. (2004). Crikey: a new method for attaching electronic devices to crocodilians. *Herpetological Review* in press.

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Kay W. R., Fitzsimmons N. N., Buchan J. C. and Grigg G. C. (submitted). Evidence for site fidelity and a recent genetic bottleneck in *Crocodylus porosus* populations from the Kimberley region in Western Australia. *Molecular Ecology*.

Moravec F., Kay W. R. and Hobbs R. P. (submitted). *Micropleura australiensis* n. sp. (Nematoda: Micropleuridae) from the body cavity of *Crocodylus johnsoni* in Western Australia. *Journal of Parasitology*.

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. Twenty of these wetlands have been selected for use in the final study. Sampling included diatoms and macroinvertebrates and the measurement of physico-chemical parameters.

Enumeration of samples has been completed. Work is continuing on species level identification of some specimens of diatoms and macroinvertebrates. Drafted sections of the thesis are being reviewed and prepared for first draft submission. Statistical analysis of environmental data is in progress with species data analysis to follow.

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

Thesis abstract
In a salinized landscape, farm dams may represent the last truly freshwater surface resource for the biota of wetlands affected by increasing salinity. One wetland threatened by increased salinity in south-west Western Australia is Lake Toolibin. It is listed as a Wetland of International Importance under the Ramsar Convention in recognition of its high conservation value, and remediation actions to halt (and possibly reverse) further increases in salinity are being undertaken at this wetland. The physico-chemistry and aquatic macroinvertebrate community of fourteen farm dams surrounding Lake Toolibin, and Lake Walbyring an adjacent wetland that has remained comparative fresh, were sampled in autumn and spring 1998. Comparison was made to previous studies of Lake Toolibin and Lake Walbyring to determine if aquatic macroinvertebrate species from these wetlands were found in the broader landscape.

Results indicate that the aquatic macroinvertebrate communities of Lake Toolibin and Lake Walbyring have been altered by increasing salinity. Both the physico-chemical and aquatic macroinvertebrate data collected from farm dams indicate a high degree of heterogeneity between sites, which is considered to be typical of that throughout the wheatbelt region of Western Australia. Of the 80 aquatic macroinvertebrate taxa previously recorded at Lake Toolibin, 41 were recorded in the surrounding farm dams and 30 from Lake Walbyring, in spring 1998. Of the 38 taxa recorded at Lake Walbyring in spring, 16 were either not collected or were rare in surrounding farm dams at the corresponding time. The aquatic macroinvertebrate community composition of farm dams was dominated by species of Coleoptera, Hemiptera, Chironomidae and Ostracoda. All species recorded from farm dams and Lake Walbyring in 1998 were considered to be freshwater species tolerant of a wide range of salinities, and cosmopolitan in distribution throughout south-west Western Australia. It was concluded that, when considered as a mosaic of habitat types and not as isolated systems, farm dams are important refuge habitats for the aquatic macroinvertebrate species of Lake Toolibin. The farm dams will provide a mechanism for the maintenance of aquatic invertebrate species richness and abundance. Refuge farm dam habitats can therefore contribute to the conservation and management of wetland biodiversity in a salinized landscape such as the Western Australian wheatbelt.

Scientist: S Halse
Student: C Gouramanis

Project title
Ostracods as indicators of lake conditions and fine –scale climate change in southern Australia

Progress report
The purpose of this project is to obtain environmental and ostracod species data from fresh to saline lakes in south-west Western Australia to be used in conjunction with a larger dataset obtained from Victoria and South Australia by Lynda Radke in order to calibrate and compare the current environmental conditions with past conditions. As such, 26 lakes and swamps were sampled from south-west Western Australia (with Jim Cocking of CALM), including Rottnest Island, with a number of physical and chemical parameters were measured and analysed by the Department of Industry and Resources Chemistry Centre. The results are currently being analysed using a number of statistical procedures and will soon be applied to a series of cores obtained from Barker Swamp (Rottnest Island) and Two Mile Lake (Stirling Ranges). A number of species have been discovered (approximately 20) with at least 1 new species to be described. These data

have already been discussed with Stuart Halse, and will be used for environmental monitoring, palaeoenvironmental reconstruction and biodiversity applications.

Scientist: L McCaw
Student: R Archibald

Project title
The role of fire in the decline of tuart (*Eucalyptus gomphocephala*) woodlands

Progress report
This study is part of a larger ARC Linkage grant that is looking at the possible roles of plant pathogens, insect pests, fire, water relations, tuart nutrition and environmental correlates on tuart decline. The fire component of the work commenced in February 2003 and is examining the role of fire on tuart regeneration by seed and resprouting, understorey dynamics, individual fire characteristics and fire regimes. Preliminary results have confirmed the capacity of tuart saplings to recover rapidly after moderate-high intensity fires as well as the importance of the immediate post-fire environment for seedling germination and growth. Two study sites (Yalgorup National Park and Yanchep National Park) have been established to examine the effect of fire intensity on tree recovery, seedling regeneration and understorey composition following prescribed burning. All pre-burn measurements are complete and have involved co-operation and collaboration between all individuals involved in the broader ARC project. Therefore, the prospect of integrating fire, insect, disease and tuart physiology research from this experiment appears promising.

A historical component is also included in the study. The resurveying of vegetation monitoring plots established in various locations in Yalgorup National park in the 1970's has commenced. In combination with fire history data and aerial photography time-series, structural and compositional patterns in tuart woodlands of the park in relation to the fire history are being explored.

Scientist: R Robinson
Student: P Scott

Project title
Identification of the causal organism associated with stem canker disease in the rare and endangered Meelup mallee (*Eucalyptus phylacis*)

Final report
This study was completed in December 2003 and results were presented in an Honours Thesis. The Meelup mallee, *Eucalyptus phylacis*, is a rare plant, Priority 2, which grows in the Cape Naturaliste region of Western Australia. It is a clonal plant with a ramet population of 27. The species is believed to be the oldest known mallee eucalypt with the most extensive clonal distribution from lignotuber expansion. The population has been subjected to human interference in the last 100 yrs and is showing evidence of decline. A detailed survey was carried out on the population in order to establish the current condition of the population, and the severity of canker and related damage. Several fungal pathogens were isolated from the cankers, including *Botryosphaeria australis* and *Cytospora eucalypticola*. In addition *Phytophthora cinnamomi* was identified from soil samples with the ramet distribution. Different strains of *B. australis* isolated from stem cankers on the plants and were identified using barrage formation between different Vegetative Compatibility Groups. The pathogenicity of isolated fungi was assessed in *E. phylacis* and in related species including *E. decipiens*, *Corymbia calophylla* and *C. ficifolia*. The data indicated the importance of *B. australis* in the canker syndrome and future research needs and conservation requirements are discussed further in the thesis.

Scientist: P Van Heurck
Student: D Herath

Project title
The impact of fire on the beetle forest floor communities in Walpole-Nornalup National Park

Progress report
Beetles were collected in Dec 2002, Feb 2003 and Dec 2003 with the help of volunteers from the Walpole-Nornalup National Park 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 and Dec 2003 samples have been sorted, and beetle morphospecies have been identified and validated to 312 species and set up as a reference collection. All sites have been visited and plant species lists, litter depths and maps of the common microhabitats have been completed at each of the sites.

The 312 beetle species are currently being analysed against the plants and microhabitats to indicate which assemblages occur in relation to fire history.

Thesis write up should be completed by August 2004.

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
- Defined and allocated DRF to floral architecture functional groups.
- Surveyed insect pollinator communities across habitat fragments.
- Measured rates of pollination and reproductive output on selected plant species in each of the functional across habitat fragments.
