Department of Environment and Conservation

Science Division annual research activity report

2006 – 2007




ACT NOW FOR THE FUTURE

Department of Environment and Conservation

Our environment, our future

DIRECTOR'S MESSAGE

This report provides a concise summary of the research activities of, and the progress made by, the Science Division of the Department of Environment and Conservation (DEC) for the fiscal year 2006/2007. Following a restructuring of DEC's Marine Conservation Branch in 2005, the activities of the Marine Science Program are included for the first time in this reporting period.

Over this period staff produced 269 publications, were active on 166 science project plans and a range of core functions, assisted or supervised 69 mostly PhD students and developed some 94 significant research 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 9 administrative regions of the State as recognized by the Department. In terms of the 26 IBRA bioregions included in Western Australia, staff were involved actively in research projects in each one. The distribution of effort was as follows:

DEC Region *	No. Projects	IBRA Bioregion **	No. Projects	IBRA Bioregion	No. Projects	IMCRA Region ***	No. Projects
Warren	74	Avon Wheatbelt	55	Jarrah forest	71	Central West Coast	1
Swan	70	Carnarvon	28	Little Sandy Desert	27	Ningaloo	9
South West	69	Central Kimberley	32	Mallee	42	Offshore Oceanic Shoals	2
South Coast	66	Coolgardie	35	Murchison	32	Pilbara onshore	4
Midwest	62	Central Ranges	26	Northern Kimberley	32	Pilbara offshore	5
Wheatbelt	61	Dampierland	31	Nullarbor	27		
Pilbara	57	Esperance Plains	52	Ord Victoria Plain	28	All State Marine Waters	7
Kimberley	52	Gascoyne	29	Pilbara	31		
Goldfields	45	Gibson Desert	26	Swan Coastal Plain	49		
		Geraldton Sandplains	43	Tanami	25		
		Great Sandy Desert	25	Victoria Bonaparte	30		
		Great Victoria Desert	26	Warren	53		
		Hampton	26	Yalgoo	32		

* 30 of these projects were relevant to all DEC regions.

** 24 of these projects were relevant to all IBRA bioregions.

*** 7 of these projects were relevant to all IMCRA regions.

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

In previous annual research activity reports, I have briefly outlined the contribution of Science Division in terms of its breadth and variety of projects, as well as the high profile enjoyed by some publications by staff.

This year I would like to include a few comments about the general ouputs and outcomes expected from public good scientific research conducted by public service scientists and technical officers. Unlike a research group in a commercial company, we don't contribute to underlying profit, share dividend, or capital return of the business enterprise.

In contrast, our strategic focus is to deliver long term benefits to our 'shareholders' – the public of Western Australia - in the form of improved understanding of how the natural world of Western Australia is put together, works, and has changed and is changing.

Other divisions of DEC manage Western Australia's surviving elements of this natural world – the national parks, nature reserves, marine parks, conservation parks and State forests. How well the public servants charged with managing the threats that these protected areas face depends to a very large extent on the facts gathered from objective scientific research and the judicious advice that scientists can provide to underpin the formulation of sound policy and effective land and conservation management.

For as long as adequate science-based information undergirds the business of DEC, the outlook for the conservation of Western Australia's species, ecological assemblages, and ecosystem processes remains positive.

This year the Science Division has put in place greater effort to provide equal opportunity for honours, masters and doctoral students and staff of the 5 Western Australian universities to work in partnership with DEC. Program Leaders have been assigned to be more proactive in forging links with staff and students. We are also developing a list of projects of an urgent nature that DEC cannot commence because of full commitment to higher priority projects. The Science Division will offer 'top up' payments to students to assist with the expense involved in carrying out research in the field, often remote from metropolitan Perth.

For an overview of the contribution of the Science Division to DEC's major predecessor, the Department of Conservation and Land Management, since its formation in 1984, please see the foreword to the Annual Research Activity Report for July 2005-June 2006.

In December 2006 we commenced revising our Strategic Plan 2008-2017. A draft was circulated to all Divisional staff for comment. After further revision this was approved by DEC's Corporate Executive in June 2007 will be posted online at http://www.naturebase.net. Our key strategic goals and actions for the next 10 years are also included in this document.

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

Dr Neil Burrows
Director, Science Division

September 2007

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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.

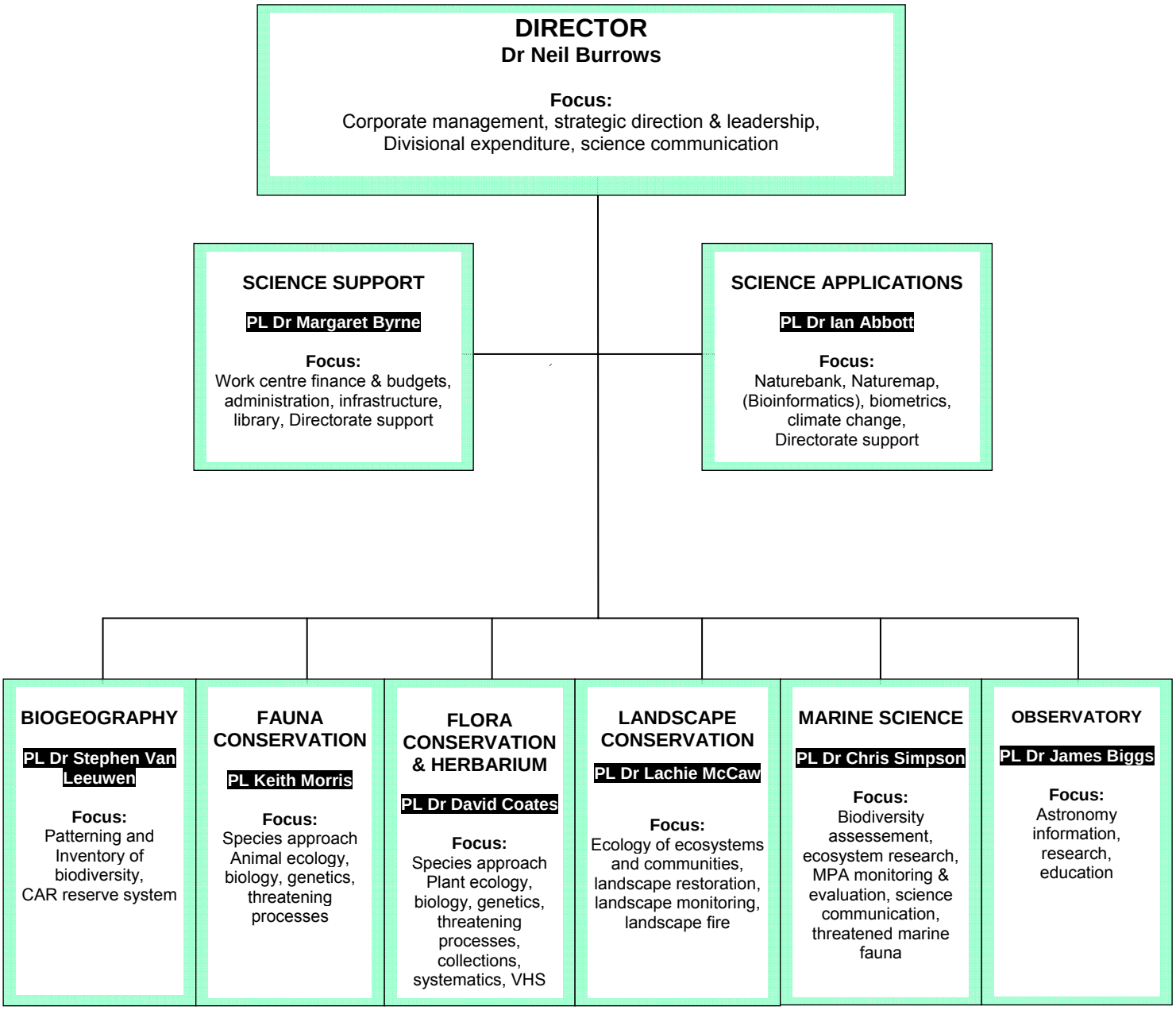
ROLE

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 Environment and Conservation (DEC), and carrying out DEC's other legislative responsibilities.
- To ensure that Science Division is responsive to the needs of policy makers and output purchasers in DEC 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 work in partnership with DEC managers, research institutions and the broader community to increase knowledge underpinning conservation and land management in WA.
- To advise DEC 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 DEC 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 DEC, 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)

DEC Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Abbott, Ian	T Simmons	Establishing bird community indices in the jarrah forest of south-west Western Australia	PhD	2001-2004 Deferred 2005	Prof J Fox and Adj Prof S Davies	Curtin University
Abbott, Ian	M Williams	Conservation and ecology of Western Australian butterflies	PhD	1999-2008 (0.4 FTE)	Prof B Lamont	Curtin University
Abbott, Ian	P Van Heurck	The compositional, structural, and functional succession of beetle communities in habitat mosaics created by 3 different fire regimes in the southern forests of Western Australia.	PhD	2005-2011 (0.5 FTE)	Prof J Majer	Curtin University
Algar, David	S Hilmer	Ecophysiology of the feral cat in Australia	PhD	2006-2009	Dr E Schleucher	Johann Wolfgang Goethe University
Algar, David	K Koch	Dietary relationships between foxes and cats in the Rangelands	Honours	2007	Dr K Schwenk	Johann Wolfgang Goethe University
Algar, David	D Oliver	Fauna assemblages at Mt Gibson and Karara	Honours	2007	Dr H Mills	University of Western Australia
Biggs, James	G Scott	Observation of mutual events of Uranus moons	PhD	2006-	Ass Prof G White	James Cook University, QLD
Biggs, James	T Greig	Data mining Asteroid Occultations	Honours	2007	Prof M Zadnik	Curtin University
Biggs, James	M Gee	Monitoring open star cluster κ Crucis	MSc	2007	Ass Prof G White	James Cook University, QLD
Biggs, James	A Sehic	Rotation periods of asteroids and comets	3rd year research project	2007	Prof M Zadnik	Curtin University
Biggs, James	A Carbone	Monitoring recently discovered novae	3rd year research project	2007	Prof M Zadnik	Curtin University
Bougher, Neale	A Francis	Sequestrate Cortinarioid fungi	PhD	2003-2007	Dr P O'Brien	Murdoch University
Burbidge, Allan	L Fox	Individual call recognition in birds	PhD	2004-2007	Dr D Roberts and Dr M Bennamoun	University of Western Australia
Burrows, Neil	J Fissioli	Predicting the distribution of tingle associations in s-w Australia	PhD	2005-2008	Dr G Wardell-Johnson	Univeristy of Queensland
Burrows, Neil	C Bishop	Impacts of fire regimes and Phytophthora on vegetation communities of the southern forests.	PhD	2005-2008	Dr G Wardell-Johnson	University of Queensland
Burrows, Neil	P Langlands	Interactions between fire and spiders in arid zone rangelands	PhD	2005-2008	Dr K Brennan	University of Western Australia
Byrne, Margaret	R Butcher	Systematics of the south-western Australian endemic	PhD	1997-2007	Prof Hans Lambers	University of Western

DEC Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
		genus *Synaphea* R.Br. (Proteaceae: Conospermineae)				Australia
Byrne, Margaret	C Tauss	Phylogeny, phylogeography and conservation of *Reedia spathacea* in south-western Australia	PhD	2002-2008	Dr G Yan	University of Western Australia
Byrne, Margaret	M Millar	An assessment of genetic risk to natural biodiversity from agroforestry revegetation	PhD	2004-2007	Dr I Nuberg	University of Adelaide
Byrne, Margaret	R Hendrati	Development of *Eucalyptus occidentalis* for revegetation	PhD	2004-2008	Dr J Plummer	University of Western Australia
Byrne, Margaret	E Dalmaris	Physiology of Wandoo decline (ARC project)	PhD	2003-2007	Prof H Lambers and Dr E Veneklaas	University of Western Australia
Byrne, Margaret	C Jones	Oil biochemistry and genetic diversity of Indian Sandalwood	PhD	2004-2007	Dr J Plummer and Dr E Ghiselberti	University of Western Australia
Byrne, Margaret	S Stankowski	Gene flow among populations of the restricted *Calothamnus* ssp. Wicher	Hons	2006	Dr I Bennett	Edith Cowan University
Byrne, Margaret	L Kroiss	Gene flow and hybridization among *Cullen* ssp.	PhD	2006-2008	Dr M Ryan	University of Western Australia
Chapman, Alex	A Spooner	Systematics and Conservation of *Lambertia* Sm. (Proteaceae)	MSc	2004-2006	Dr K Lemson	Edith Cowan University
Coates, Dave	C Waters	Developing seed provenance zones for Australian native grasses	PhD	2002-2005	Dr J Virgona	Charles Sturt University, NSW
Cochrane, Anne	B Vincent	Research into the germination physiology and ecology of the priority and significant flora on RNO tenements at Bandalup Hill Nickel mine in relation to recruitment and regeneration	PhD	2005-2009	Dr J Plummer	University of Western Australia
de Tores, Paul	J Clarke	Translocation outcomes for the western ringtail possum (*Pseudocheirus occidentalis*): An assessment of survivorship, habitat use, population demographics and health of western ringtail possums following translocation, and determination of the extent of competition between western ringtail possums and common brushtail possums (*Trichosurus vulpecula*)	PhD	2006-2008	Dr K Warren and A/Prof I Robertson	Murdoch University
de Tores, Paul	H McCutcheon	Ecology and disease of the western ringtail possum (*Pseudocheirus occidentalis*) and common brushtail possum (*Trichosurus vulpecula*)	PhD	2006-2008	Dr K Warren and A/Prof I Robertson	Murdoch University
de Tores, Paul	G Bryant	The ecology of the south-west carpet python *Morelia spilota imbricata* in the northern jarrah forest of south-west Western Australia. Its role as a mesopredator – is it limiting success of translocated mammal populations?	PhD	2006-2008	Dr K Warren and Dr T Fleming	Murdoch University
de Tores, Paul	J Cruz	What factors regulate brushtail possum populations, *Trichosurus vulpecula*, in the northern jarrah forest, Western Australia? Identifying	PhD	2006-2010	L Leung	University of Queensland

DEC Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
		effects of long term fox control on brushtail population dynamics, behaviour and predator-prey interactions				
de Tores, Paul	A Nowicki	An assessment of the seasonal availability of alternative prey species to predators of the western ringtail possum, *Pseudocheirus occidentalis*	Hons	2006-2007	K Bryant	Murdoch University
de Tores, Paul	T Moore	Western Ringtail Possum (*Pseudocheirus occidentalis*) preference for nest boxes, and nest box use after translocation	Hons	2007	T Fleming	Murdoch University
Farr, Janet	K Ironside	The effect of fire on the trophic dynamics of predatory invertebrates	MSc	2006-2009	Dr J Prince	University of Western Australia
Farr, Janet	S Danti	The influence of 2 different silvicultural treatments on coarse woody debris and saproxylic beetle assemblages in southern forests of Western Australia.	MSc	2007-2009	Dr A Kinear	Edith Cowan University
Friend, Tony	J Austen	Trypanosomes of some Western Australian mammals: phylogenetics and ecology	PhD	2006-2009	Dr S Reid	Murdoch University
Friend, Tony	R Vaughan	Epidemiological aspects of health management of Gilbert's potoroo (*Potorous gilbertii*)	PhD	2006-2008	Dr K Warren and Dr S Fenwick	Murdoch University
Keighery, Greg	P Goldsmith	Buffel Grass Seed Predation and Dispersal in the Shark Bay Area	Hons	2006-2007	Dr H Spafford-Jacobs	University of Western Australia
Halse, Stuart	E Lowe	Macroinvertebrates and diatoms as indicators of acidity in wetlands of Western Australia	PhD	2000-2006	A/Prof J John	Curtin University
Halse, Stuart	C Gouramanis	Ostracods as indicators of lake conditions and fine-scale climate change in southern Australia	PhD	2003-2006	Prof P De Deckker	Australian National University
Long, Suzanne	B Fowles	Shifting baselines for fisheries at Ningaloo Marine Park	Hons	2007	Dr A Gaynor	University of Western Australia
Long, Suzanne	D Holley	Northwest dugong population and habitat use	PhD	2007-9	Dr P Lavery	Edith Cowan University
Long, Suzanne	L D'Andrea	Using hyperspectral data to map vegetation cover and condition of the coastal area at Coral Bay, WA	MSc	2007	Dr H Kobryn	Murdoch University
Long, Suzanne	J Neimann	Diurnal variability in beach use patterns at Bundegi, Turquoise Bay and Coral Bay, Ningaloo Marine Park	MSc	2007	Prof L Beckley	Murdoch University
McCaw, Lachie	F Metcalfe	Spatially explicit modelling of fire severity in south-west forest ecosystems, Western Australia	PhD	2007-2010	Dr P Grierson, Dr K Van Niel, Dr N Burrows and Mr J Gould	University of Western Australia
McCaw, Lachie	J Cargill	Fate of *Eucalyptus marginata* seed from canopy store to emergence in the northern jarrah forests of Western Australia	PhD	2006-2009	Prof W Stock and Dr E van Etten	Edith Cowan University
McCaw, Lachie	J Hollis	Coarse Woody Fuel Availability and Consumption in Australian Forests Fires	PhD	2007-2010	Dr W Anderson, Dr J Chapman, Dr P Ellis and Dr S Matthews	University of New South Wales

DEC Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
McCaw, Lachie	A O'Donnell	Fire patterns and vegetation structure in semi-arid woodlands and shrublands in southern Western Australia	PhD	2006-2009	Dr P Grierson and Dr M Boer	University of Western Australia
Morris, Keith	D Cancilla	Ecology of the heath mouse *Pseudomys shortridgei*	PhD	2003-2006	Dr G Hardy	Murdoch University
Morris, Keith	F Donaldson	Social structure of burrowing bettongs	PhD	2003-2006	Dr R Bencini	University of Western Australia
Morris, Keith	M Cardoso	Genetic consequences of translocation in chuditch	PhD	2005-2007	Dr K Firestone	University of NSW
Morris, Keith	N Willers	The use of contraceptive implants to control overabundant rock wallaby populations	PhD	2006-2008	Dr R Bencini	University of Western Australia
Pearson, David	L Delfs	Lizards of the *Tiliqua* genus in the urban environment	PhD	2003-2006	Dr M Pennachio, Dr D Groth and Dr J Wetherall	Murdoch University
Pearson, Grant	T Compton	The phenotypic response of the local Tellinidae to their environment	PhD	2003-2007	Prof T Piersma	Royal Netherlands Institute for Sea Research
Robinson, Richard	P Anderson	Impact of *Phytophthora cinnamomi* on macrofungal diversity in the northern jarrah forest	4th Yr research project	2007	Dr P Grierson Dr M Brundrett	University of Western Australia
Shearer, Bryan	S Collins	Survival of *Phytophthora cinnamomi* in rehabilitated bauxite mining areas	PhD	Completed 2007	Dr G Hardy	Murdoch University
Shearer, Bryan	T Papp	Epidemiology of marri canker	PhD	Completed 2007	Dr G Hardy	Murdoch University
Shearer, Bryan	K Smith	The role of chlamydospores in the survival of *Phytophthora cinnamomi*	PhD	Completed 2007	Dr G Hardy	Murdoch University
Shearer, Bryan	P Scott	Tuart decline	PhD	2004-2007	Dr G Hardy	Murdoch University
Shearer, Bryan	R Hooper	Wandoo decline	PhD	2004-2007	Prof K Sivasithamparam	University of Western Australia
Shearer, Bryan	P Staskowski	Mechanisms of Phosphite action	PhD	2006-2009	Dr G Hardy	Murdoch University
Shearer, Bryan	N Jardine	Mechanisms of Phosphite action	PhD	2006-2009	Dr G Hardy	Murdoch University
Shearer, Bryan	C Bishop	Impact Phytophthora cinnamomi	PhD	2006-2009	Dr Grant Wardell-Johnson	University of Queensland
Shearer, Bryan	C Gilovitz	Intraspecific resistance to Phytophthora cinnamomi in Lambertia	Hons	2007	Dr G Hardy	Murdoch University
Start, Tony	T Partridge	Study of fire, small mammals and cats in Purnululu National Park	PhD	2003-2005		Macquarie University
Start, Tony	C Palmer	Study of 4 CWR mammals, their habitat requirements and the effect of fire on those requirements	PhD	2003-2005	Dr J Woinarski	Northern Territory University
Stukely, Mike	A Rea	Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species	PhD	2007-2010	Dr G Hardy	Murdoch University
van Leeuwen, Stephen	G Page	Ecology and physiology of Mulga types at West Angelas, Pilbara, Western Australia	PhD	2005-2008	Dr P Grierson	University of Western Australia
Wayne, Adrian	K Bain	Ecological study of the quokka (*Setonix brachyurus*) in the southern forests of south west WA	PhD	2006-2012	Dr R Bencini	University of Western Australia

DEC Officer	Student	Project Title	Degree/ level	Duration (yr - yr)	University Academic	University
Wayne, Adrian	C Pacioni	A conservation conundrum: the population and epidemiological dynamics associated with recent decline of woylies (*Bettongia penicillata*) in Australia.	PhD	2006-2009	Dr K Warren, Prof I Robertson and Dr P Spencer	Murdoch University
Wayne, Adrian	K Rodda	Resource availability and Woylie declines in south-western Australia	PhD	2007-2010	Dr K Bryant	Murdoch University
Yates, Colin	A Franks	Landscape fragmentation and rare plant species: Can we develop a general framework of population responses?	PhD	2002-2007	Prof R Hobbs	Murdoch University
Yates, Colin	K Maher	Fire, fragmentation and mammals, synergistic impacts on ecosystem dynamics	PhD	2004-2007	Prof R Hobbs	Murdoch University

EXTERNAL PARTNERSHIPS

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
ABRS	Taxonomy of *Baeckea*:	$150k for 5 yrs, $22k in 2005-2006	B Rye (0.5), Curatorial (0.05) 1 Scientist (M Trudgeon)
ABRS	Western Australian Marine Plants Online	2007/8 – $40,700 2008-2010 - $94,600	J Huisman (0.1), B Richardson (0.05)
AIMS	Planning for a marine biodiversity survey of the Rowley Shoals	$15k in 2006-2007	S Long (0.10)
AMSA WA	Rottnest Young Scientist Workshop	$500 sponsorship (all MSP CF)	C Simpson (0.01)
ANZEC / CRC for Australian Weed Management	Technical Group for weeds of conservation significance	Nil	G Keighery (0.05)
ARC Linkage, Murdoch University, University of Sydney, University of Wales-Bangor	Conservation of the threatened western ringtail possum, Pseudocheirus occidentalis: is translocation a solution?	ARC $120k p.a. over three years, plus funds ex developers	P de Tores (0.20), D Algar (0.025), W Roe (0.05), M Humble (0.025), F Colyer (0.025)
ARC Linkage, University of Sydney, Department of Environment and Water, Australian Reptile Park	Predicting the ecological impact of cane toads on native fauna of north western Australia	External: $503k over 3 yrs DEC: $20k cash for 3 yrs; $112k in kind	D Pearson (0.5)
ARC Linkage, University of Queensland, University of Western Australia	Broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems	External: $120k for 3 yrs DEC $20k for 3 yrs	N burrows (0.05), B Ward (0.2), G Liddelow (0.2), R Cranfield (0.1), J Farr (0.1), A Wills (0.1), P Van Heurck (0.1), R Robinson (0.1), B Smith (0.1), K Bain (0.05), D Green (0.05), T Middleton (0.05), L Shu (0.05), vacant (0.1)
Australia's Virtual Herbarium Trust	AVH: Australia's Virtual Herbarium: Databasing of cryptogam collections	2007 - $48K	C Parker (0.1), S Carroll (0.1)
Avon Natural Diversity Alliance (ANDA)	ND001 Baselining natural diversity data in Avon Catchment	$760k first year, $600k 2nd year, $450k 3rd year Externally funded: J Hogben, J Richardson, B Bayliss, T Gamblin	P Gioia (0.1), A Pinder (0.05).
Bureau of Meteorology	Weather monitoring - Perth Observatory information core function	Nil	0.01 FTE TO
Bushfire CRC	Improved methods for the assessment and prediction of grassland curing evaluation of fire suppression techniques and guidelines managing fires in forest landscapes SW Australia	2006-08 $150k	L McCaw (0.4), R Robinson (0.2), J Farr (0.2), B Ward (0.2), G Liddelow (0.2), J Fielder (0.2), G Phelan (0.2), F Metcalfe (0.2), Li Shu (0.2) (2.01 FTE pa)
CAFE (CALM Alcoa Forest Enhancement) program	The importance of fox, cat and native predator interactions to sustained fauna recovery in the northern jarrah forest – is there a mesopredator release effect?	$84,500 p.a.	P de Tores (0.75), J Asher (0.01), N Powell (0.01)
Chevron-Texaco	Monitoring mammals on Barrow Island	$6k pa for 5 yrs	K Morris (0.05), A Burbidge (0.05)
Clarion U & Oil Region Astronomical Society	Internet telescope	$5k	0.02 FTE Scientist, 0.1 FTE TO
CRC for Plant Based Management of Dryland Salinity	Biodiversity Program Project - Management of weed and genetic risk in perennial landuse systems	$756k over 4 yrs (2004-2008)	M Byrne, M Lyons, S Halse, N Gibson

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
Commonwealth Department of Environment and Water Resources (DEW), (formerly DEH)	Preparation of a recovery plan for the quokka, Setonix brachyurus	$38k	P de Tores (0.05)
Commonwealth Department of Environment and Water Resources (DEW), (formerly DEH) and Murdoch University	identifying areas of high conservation value for the western ringtail possum	$50k (of which 50% paid directly to Murdoch University)	P de Tores (0.05), S Elscot (0.50)
Commonwealth Department of Environment and Water Resources	Development of profiles for Weeds of National Significance	2007 - $5K	K Thiele (0.05)
CSIRO	Pilbara Biological Survey:Australian National Insect Collection curation and identificationof Coleoptera	$10k for 2007	N Guthrie (1.0)
CSIRO Marine and Atmospheric Research	Particles, ozone and air toxic levels in rural communities during prescribed burning seasons	$8k for conducting weekly air quality sampling and providing fire data	L McCaw
CSIRO Sustainable Ecosystems	Fire regimes and biodiversity decline in the Kimberley	$101.4k for 3 yrs, 2006-2009	I Radford
CSIRO Sustainable Ecosystems	Fire, fragmentation, weeds and the conservation of plant biodiversity in Wheatbelt nature reserves	$60k for 3 yrs, 2006-2009	C Yates, C Gosper
Curtin University and James Cook University, Queensland	Student project supervision (at tertiary level) - Perth Observatory education core function	Nil	0.05 FTE scientist
Curtin University and University of Western Australia	Lecturing - Perth Observatory education core function	Nil	0.2 FTE scientist
Curtin University, Environmental Biology	Pilbara Biological Survey: Ant identifications	$10k for 2006-2007	B Durrant (0.1), S van Leeuwen (0.05)
Department of Agriculture Western Australia	GIS vegetation mapping	2002-03 - $20k 2003-04 - $10k	G Serendenco (0.3)
Department of Environment and Water Resources (Cwth)	AVH: Australia's Virtual Herbarium: 2.1 - database, curation, identification	$400k for 2001-2005, $42k for 2005-2006, $48k for 2006-2007	A Chapman (0.1), C Parker (0.1), S Carroll (0.1)
Department of Environment and Conservation	Swan Bioplan (Strategic Policy Division)	$160k for 3 yrs, 2006-2008	G Keighery (0.2)
Department of Premier and Cabinet	Bushplan	$100k for 2003-2004	A Hopkins (1.0)
DSE (Victoria) and Department DEWR (Commonwealth)	PAPP toxicosis	$100k per yr from DEWR and $10k in kind DEC	D Algar (0.05), K Morris (0.02)
Fire Protection Services, DEC	Fire monitoring - Perth Observatory information core function	Nil	Nil
GCN (Gamma Ray Burst Communication Network), USA	Supernova search - SPP # 98/0014	Nil	0.05 FTE 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
International Science Linkages	Resolving determinants of plant diversity and vegetation structure at different spatial scales for the conservation of high rainfall mediterranean-climate ecosystems	$5k one off	Access to databases
Invasive Animals CRC	Demonstration site – mesopredator release	$1 155k over 3 yrs	K Morris (0.3), P de Tores (0.75), N Marlow (0.75), D Algar (0.5), B Johnson (1.0), W Muir (0.25), J Angus (0.5), M Onus (0.5), N Thomas (1.0), A Williams (0.9)

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
Land and Water Australia / CSIRO	Genetic & ecological viability of plant populations in remnant vegetation	$200k CSIRO/LWA; $150k DEC contribution	D Coates (0.4), M Byrne (0.1), C Yates (0.2), T llorens (1.0), B MacDonald (0.1), H. Nistleberger (1.0)
Lotteries West	Insect databasing - DEC's insect collection	$7.4 final funding	Database (0.05) 1 databaser
Lowell Observatory, USA University of Maryland, USA	SPP # 98/0010 - Imaging and spectrophotometry of comets	$2k	0.13 FTE scientist, 0.1 FTE TO
Millennium Seedbank Project	Seed collection, storage and biology	$210k yr to 2009	A Cochrane (0.8), D Coates (0.1)
Murdoch University	Western barred bandicoot disease studies	$15k pa for 3 yrs – ARC Linkage Grant	T Friend (0.05)
Murdoch University	ARC Linkage Project – Landscape fragmentation and rare plant species	$27k for 2002; $28k for 2003; $28k 2004. PhD student A Franks	C Yates (0.2) $7 500 yr for 2002-2004
Murdoch University	ARC Linkage– The role of disease factors in regulating fauna populations	$30k 2007-2009; $28k 2007-2008	K Morris (0.05)
Murdoch University	Survival of *Phytophthora cinnamomi* in rehabilitated bauxite mining areas	Nil - S Collins (PhD student)	B Shearer (0.04)
Murdoch University	Phosphonate distribution in *Eucalyptus marginata* Donn ex Sm. forest and colonization by *Phytophthora cinnamomi* Rands	Nil - R Pilbeam (PhD student)	B Shearer (0.04)
Murdoch University	Fire, fragmentation and mammals, synergistic impacts on ecosystem dynamics	$30k pa for 3 yrs PhD student Kellie Maher LWA Stipend	C Yates (0.2)
Murdoch University	Epidemiology of marri canker	Nil	B Shearer (0.4)
Murdoch University	PhD student Alex Rea Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species	$5,000 from DEC (VHS) in 2007-2008	M Stukely (0.05)
Murdoch University	The extraction of DNA from reptile scales and sloughed skins	Nil	D Pearson (0.05)
Murdoch University	Population viability analysis of the Perth metropolitan population of the little penguin	$7.5k in 2006-2007; $20k top-up in 2006-2007; $7.5k for 2007-2008 (all MSP CF) - ARC Linkage	C Simpson (0.01), S Long (0.01)
Murdoch University	An ecosystem approach to estimating the viability of bottlenose dolphin populations	$30k for 3 years; 2006-2007-2008 (all MSP CF) - ARC Linkage	C Simpson (0.01)
Murdoch University	Relationships between habitat types and fish assemblages at Broke Inlet	$9.3k in 2006-2007; (all MSP CF)	C Simpson (0.01)
Murdoch University, Edith Cowan University, Alcoa, City of Mandurah	Tuart woodland decline (ARC project) including support for a PhD student	$280k over 3 yrs ARC $195k over 3 yrs from Industry; $20k per yr DEC	D Haswell (0.05), L McCaw (0.05)
Murdoch University/ Ravensthorpe Nickel	Management guidelines for the threatened heath mouse and other rodent species in mining lease areas of southern WA	ARC Linkage Grant - $5 k yr for 2003-2005 from Stipend funds (DEC contribution) PhD student – D Cancilla	B Johnson (0.4), K Morris (0.05)
Murdoch University, University of WA, Water Corp., Department of Health, ALCOA	Risks to human health and to ecosystems from feral pigs in the Perth Metropolitan Water Catchments	ARC Linkage DEC $5k pa for 3 yrs	N Burrows (0.01) D Algar (0.05)
Netherlands Institute for Sea Research (NIOZ)	Benthic studies – Roebuck Bay, NHT + Wettenhall – Roebuck Bay book	$27k	G Pearson (0.15)

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
Netherlands Institute for Sea Research (NIOZ)	Bivalve diversity at tropical and temperate tidal flats: a comparison using spatial niches, morphology and physiology	$5k from Stipend funds (DEC)	G Pearson (0.05) PhD – T Compton
NHT	Western bristlebird research plan	$99 387	AH Burbidge (0.1)
NHT	Western ground parrot recovery	$150k	AH Burbidge (0.1), B Barrett (1.0)
NHT	Regional assessment of the conservation status of vegetation units throughout WA (Beard)	$31 525	A Hopkins (0.1)
NHT	Nomination and improved documentation of nationally important wetlands in under-represented IBRA regions in WA	$70k for 2003-2005	S Elscot (0.25), G Pearson (0.1), A Clarke (0.2), J Lane (0.15)
NHT Regional Competitive Component	Securing a future for the dibbler – cross-regional recovery program	$108k pa for 3 yrs	T Friend (0.1
NHT2	Preparation of a recovery plan for rock-wallabies	$35k	D Pearson
NHT2	Seed conservation program	$85k pa to 2008 (SCRIPT)	A Cochrane (0.5)
Pilbara Iron Pty Ltd & University of Western Australia	Pilbara water use study	$42k	N Gibson (0.05), S van Leeuwen (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)
Robe River Iron Associates (West Angelas Coondewanna West Environmental Offsets)	Fire-Mulga study: post burn monitoring	$20k	S van Leeuwen
San Diego State University (USA)	Manipulating microbes to conserve coral reefs	-	C Simpson (0.001)
Scitech Planetarium, UWA, STAWA	Astronomy education	$5k (from grant)	0.05 FTE scientist
SCRIPT	Dibbler distribution and ecology in Fitzgerald River NP	$60k pa for 3 yrs	T Friend (0.1)
SCRIPT	Gilbert's potoroo recovery program	$187k pa for 3 yrs	T Friend (0.75)
SCRIPT	Numbat recovery program, South Coast	$34k pa for 3 yrs	T Friend (0.05)
South African National Biodiversity Institute	Guidelines for bioclimatic modelling, monitoring and data management.	DEC contribution $226,914	R McKellar, I Abbott, C Yates, P Gioia
Space Telescope Science Institute, USA; Sth 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
Tropical Savannas CRC	Kimberley mammals	$55k for 2002-2003; $55k for 2002-2004; DEC contributes $10k pa into CRC - S Black's contract was paid for by DEC	T Start (0.8), N McKenzie (0.1), J Rolfe (0.1), S Black (0.25), A Burbidge (0.1)
University of Adelaide	ARC Linkage Grant – A comparative study of the distribution and spread of potential molecular markers for Mundulla Yellows disease	$5k pa from DEC for 2004-2006 as an industry partner	M Stukely (0.1) equipment, vehicle

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
University of Adelaide	Pilbara biological survey/Wetland monitoring program – rotifer and cladoceran identifications - Dr R Shiel	DEC contribution $20k	A Pinder (0.05), D Cale (0.05)
University of California, Berkeley & Lawrence Hall of Science	Hands on Universe - Internet telescope	$5k	0.03 FTE Scientist, 0.1 FTE TO
University of Melbourne	Pilbara biological survey planktonic algae identifications - Dr J Powling	$12K	M Lyons (0.05)
University of New South Wales, University of Western Australia	The use of contraceptive implants to control overabundant marsupials	$10k	K Morris (0.05)
University of Northern Arizona	Pilbara biological survey diatom identifications - Prof D Blinn	DEC contribution $15k	A Pinder (0.05)
University of Queensland, University of WA	Broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems	ARC Linkage External: 120k for 3 yrs DEC $20k for 3 yrs	N Burrows (0.02), B Ward (0.2) G Liddelow (0.2) R Cranfield (0.1) J Farr (0.1) A wills (0.1) P Van Heurck (0.1) vacant (0.1) R Robinson (0.1) B Smith (0.1) K Bain (0.0-5) D Green (0.05) T Middleton (0.05) L Shu (0.05)
Unviersity of WA, SWCC, SCRIPT	Aboriginal landscape transformations in south-western Australia	DEC $6k for 3 yrs ARC Linkage	N Burrows (0.01)
University of Western Australia	Benchmark study on marine communities of the south-west for long-term monitoring	$5k in 2006-2007; (all MSP CF)	K Bancroft (0.01)
University of Western Australia	Social structure of burrowing bettongs	$5k pa for 2003-2005 from Stipend funds (DEC) PhD – F Donaldson	K Morris (0.05), equipment
University of Western Australia	Mode of action of phosphonate in native hosts to *Phytophthora cinnamomi*	Nil - PhD student – B Komorek	B Shearer (0.04)
University of Western Australia	Processes in lateritic soil in Western Australia	Nil - PhD student - A Koning	B Shearer (0.04)
Urban Bushland Council, WA Naturalists Club, Lotteries West	PUBF: Perth Urban Bushland Fungi project: Education Officer	2003-2006: $335k; $47k in 2005-2006	N Bougher (0.05), R Hart (0.5), S de Bueger (0.5)
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)
Victorian Department of Sustainability and the Environment & Federal Department of Environment and Heritage	PAPP toxicosis in cats	$10K (in kind)	D Algar (0.02), K Morris (0.02)
Walpole - Nornalup National Parks Association and Walpole Wilderness Eco-Cruises	The impact of wildfire on invertebrate communities in old growth forests	$45k for 2004-2007	P Van Heurck (0.1), I Abbott (0.1), T Middleton (0.1), WNNPA volunteers (10 x 0.2 =2.0)
WAMSI	North West Shelf Inventory Project	$15k for 2007/08	K Waples (0.01)
Western Australian Fisheries, WAMSI	Pinniped management plan and implementation of sea lion monitoring	$50k from NC, $20k from SD, $30k from JBMP	R Campbell (0.5)
Western Australian Local Government Association	Perth Biodiversity Project (completed)	$15k for 2 yrs, 2004-2006	G Keighery (0.05)
Western Australian Museum	Inventory and databasing of marine faunal records from the NW atolls	$60k for 2007-2008 (all MSP CF)	S Long (0.01)
Western Australian Museum	NatureMap	Nil	P Gioia (0.6)

Partnership Name **i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)**	**Project**	**Cash funding and source ($)**	**DEC Involvement (in kind)**
Western Australian Museum	Biogeography of insular populations in the Abrolhos	$ 5k (Midwest Region)	D Pearson (0.05)
Western Australian Museum	Pilbara Biological Survey	$500k in-kind in 2005-2006	N McKenzie (0.6), S Halse (0.5), AH Burbidge (0.9), L Gibson (1.0)
World Wildlife Fund - Australia	Woodland Watch	2006-7 - $30K	K Thiele (0.05)
Worsley Alumina Pty Ltd	The importance of fox, cat and native predator interactions to sustained fauna recovery in the northern jarrah forest – is there a mesopredator release effect?	$80k pa for 3 years	P de Tores (0.75), J Asher (0.01), N Powell (0.01)
Department of Fisheries	Introduced Marine Pests	$28k for 2006-2007 (Salary)	J Huisman (0.3)

Note: 1k = $1 000

SUMMARY OF RESEARCH PROJECTS by DEC and NRM REGIONS

DEC Region	NRM Region	Project Title	Page
Biogeography Program: Stephen van Leeuwen			
Pilbara	Rangelands	Pilbara regional biological survey	47
Kimberley	Rangelands	Kimberley islands biological survey	48
Goldfields, Midwest, South Coast	Rangelands, Northern Agricultural, South Coast	Floristic survey of the banded ironstone formations (BIF) and greenstone ranges of the Yilgarn and Ravensthorpe Range	49
Wheatbelt, South Coast, Midwest, Northern Forest, South West	Avon, South West, Northern Agricultural, Rangelands	Biological survey of the agricultural zone (SAP Survey)	50
Swan, South West	Swan, South West	Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain	51
All	All	Ecomorphological clues to community structure, bat echolocation studies	52
All	All	Conservation of Western Australia's vegetation assemblages; Interim framework for developing a CAR reserve system for WA; Land-use and vegetation mapping; Identifying land with high nature conservation values in the Gascoyne Murchison strategy area	53
All	All	Biodiversity audit	5555
All	All	National reserve system working group	56
All	All	Provision of biogeographical information for DEC management plans, NRM advice scientific liaison and membership of scientific advisory committees	56
Pilbara	Rangelands	De-commission the Pilbara Regional Herbarium	57
Kimberley	Rangelands	Kimberley Nature Conservation output liaison, including submissions to acquire funding support for Kimberley islands biodiversity survey	58
Fauna Conservation Program: Keith Morris			
Midwest, Goldfields	Rangelands	Development of effective broadscale aerial baiting strategies for the control of feral cats	60
Midwest	Northern Agricultural, Rangelands	Sustained introduced predator control in the Rangelands	62
South Coast, Warren	South Coast, South West	Conservation of south coast threatened birds	63
Swan, South West	South West	Translocation outcomes and monitoring of naturally occurring populations of the western Ringtail possum, *Pseudocheirus occidentalis*	65
Swan, South West	South West, Swan, Avon	The importance of fox, cat and native predator interactions to sustained fauna recovery in the northern jarrah forest – is there a mesopredator release effect?	66
Swan, Wheatbelt, Warren, South Coast	South West, Swan, Avon, South Coast	Factors affecting establishment in the numbat (*Myrmecobius fasciatus*) recovery plan	69

DEC Region	NRM Region	Project Title	Page
Wheatbelt	South West, Avon	An assessment of the effect of fox control on *Phascogale calura* (red-tailed phascogale) populations	71
Midwest, South Coast	Northern Agricultural, South Coast	Dibbler (*Parantechinus apicalis*) Recovery Plan	72
South Coast	South Coast	Gilbert's potoroo (*Potorous gilbertii*) Recovery Plan	74
Midwest	Rangelands, Avon	Genetics and ecology of the western barred bandicoot (*Perameles bougainville*)	76
Wheatbelt, South Coast	Avon, South Coast	Status and ecology of the heath mouse (*Pseudomys shortridgei*) in Western Australia	77
Warren, South West, Swan	South West, South Coast	Rapid survey of quokka (*Setonix brachyurus*) in the southern forests	78
Warren	South West	Monitoring selected vertebrate communities in the Perup Nature Reserve	78
Warren, South West	South West	Assessing the distribution and status of the wambenger	79
Goldfields, Wheatbelt, Warren, South West	Avon, South West, Rangelands	Probait trials: phase 2	80
Wheatbelt	Avon, South West	Sustained fauna recovery in a fragmented landscape (Dryandra Woodland and Tutanning Nature Reserve): is there a mesopredator release effect?	81
Wheatbelt, South Coast, Swan, South West, Warren	South West, Swan, Avon, South Coast	Implementation of the Recovery Plan for the chuditch, *Dasyurus geoffroii*	82
Midwest	Northern Agricultural	Management of overabundant marsupials – North Island tammar wallaby case study	83
Pilbara	Rangelands	Monitoring of mammal populations on Barrow Island	85
Wheatbelt, Katanning work centre	Avon Catchment	Factors affecting fauna recovery in the Wheatbelt – Lake Magenta and Dunn Rock Nature Reserves	86
Swan, Midwest	South West, Rangelands, Northern Agricultural	Ecology and conservation of threatened pythons in WA	87
Midwest	Northern Agricultural	Implementation of the Lancelin Island Skink Recovery Plan	88
All except South West	State wide	Improving rock-wallaby conservation and management	89
Kimberley	Rangelands	Impact of cane toads on biodiversity in the Kimberley	90
Midwest, Pilbara, Kimberley	Rangelands, Northern Agricultural, Swan, South West	Conservation of marine turtles	92
Wheatbelt	South West, Avon	Return to Dryandra	93
Kimberley	Rangelands	The status of critical weight range (CWR) mammals in the Kimberley – a reassessment	94
Warren	South West	Ecology of the ngwayir (*Pseudocheirus occidentalis*) and koomal (*Trichosurus vulpecula hypoleucus*) in the jarrah forest	95
Warren	South West	Identifying the cause(s) of the recent declines of woylies in south western Australia	96
Swan, Goldfields	Swan, Rangelands	Conservation of Western Australian butterflies	98
Swan, South West	Swan	Native earthworms (Oligochaeta) of the Swan Coastal Plain: biodiversity, distribution and threatening processes	99
Flora Conservation Program: David Coates			
South Coast, Midwest, Swan, Wheatbelt, Goldfields	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora	101
Wheatbelt	Avon, Northern Agricultural, South Coast, Swan	Genetic and ecological viability of plant populations in remnant vegetation	102
Wheatbelt, Midwest, Swan, South West, South Coast, Warren	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance	104
All	Avon, Northern Agricultural, Rangelands,	Seed biology, seedbank dynamics and collection and storage of seed of rare and threatened Western	105

DEC Region	NRM Region	Project Title	Page
	South Coast, South West, Swan	Australian taxa	
All	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Weeds of Western Australia: advice, liaison, publicity and documentation	106
Midwest, South Coast, South West, Wheatbelt	Avon, Northern Agricultural, South Coast, South West, Swan	Experimental translocation of Critically Endangered plants	108
South West, South Coast	Avon, South Coast, South West, Swan	Integrated strategies for the control of *Phytophthora cinnamomi* using phosphite	109
Midwest, Swan, Wheatbelt, South West, Warren, South Coast	Avon, South Coast, South West, Swan	Susceptibility of rare and endangered flora to *Phytophthora*	110
South Coast	South Coast	The use of High Intensity Phosphite techniques to control *Phytophthora cinnamomi*	110
Warren, South West, Swan, Wheatbelt	Avon, South Coast, South West, Swan	Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*	111
South West, Swan	Avon, South Coast, South West, Swan	Dieback-resistant jarrah establishment in operational forest rehabilitation sites	113
Swan, South West, Midwest, Wheatbelt, South Coast, Warren	Northern Agricultural, Swan, Avon, South West, South Coast, Rangelands	Mundulla Yellows disease in Western Australia	114
Midwest, Swan, South West, Warren, South Coast, Wheatbelt	Northern Agricultural, Swan, Avon, South West, South Coast	Vegetation Health Service	116
Goldfields, Midwest, South West, South Coast, Swan, Wheatbelt	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	The population ecology of Critically Endangered flora	118
Goldfields	Rangelands	Causes of rarity in 4 *Tetratheca* taxa in the goldfields ranges	119
Wheatbelt, Midwest, Swan, South Coast	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Taxonomic studies on native and naturalized plants of Western Australia arising from biological survey	120
Pilbara	Rangelands	Wattles of the Pilbara	121
All	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Conservation status and systematics of Western Australia *Acacia*	122
Wheatbelt	Northern Agricultural	Wattles in the Shire of Dalwallinu	123
Pilbara, Midwest, Goldfields	Rangelands	Understanding Mulga	124
All	All	Taxonomic review and conservation status of the members of the Myrtaceae tribe Chamelaucieae and miscellaneous other Western Australian plant groups	125
Midwest, Goldfields, Wheatbelt, South Coast	Rangelands, Northern Agricultural, South Coast	Resolution and description of new plant species in the Yilgarn ironstone and Ravensthorpe	126
All	All	Taxonomy of undescribed conservation taxa in the epacrid genera Leucopogon, Monotoca and Oligarrhena	127
All	All	Taxonomy of selected families including legumes, grasses and lilies	129
All	All	Taxonomic studies in selected families, including Astereaceae, Celastraceae Malvaceae, Proteacea	130
All	All	Herbarium collections management	131
All	All	Western Australian plant census and Australian plant census	133
All	All	The WA Herbarium's specimen database	134
All	All	Nuytsia – Western Australia's journal of systematic botany	135
All	All	FloraBase – the Western Australian Flora	136
Kimberley, Pilbara, Swan, South West, Warren, South Coast	Rangelands, Northern Agriculture, Swan, South West, South Coast	Taxonomic review and floristic studies of the benthic marine algae of north-western Western Australian and floristic surveys of Western Australian marine benthic	137

DEC Region	NRM Region	Project Title	Page
		algae	
Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast	Rangelands, Northern Agriculture, Swan, South West, South Coast	The Western Australian marine benthic algae online and an interactive key to the genera of Australian marine benthic algae	139
Swan	Swan	Perth Urban Bushland Fungi Project	140
All	All	Improving the comprehensiveness, accuracy and availability of taxonomic data about WA's fungi in DEC biological datasets and biodiversity collections	141
Landscape Conservation Program: Lachie McCaw			
Warren, South West, Swan	South West, Swan	FORESTCHECK – Integrated site-based monitoring of the effects of timber harvesting and silviculture in the jarrah forest	143
South West, Warren	South West	Long-term effects of various fire regimes on species richness and composition of southern jarrah forest understorey	144
Kimberley	Rangelands	Demography of Australian Boab (*Adansonia gregorii*) stands in relation to fire and grazing	145
Goldfields	Rangelands	Project Desert Dreaming: Developing sustainable management systems for the conservation of biodiversity at the landscape scale in the Gibson Desert and Gascoyne bioregions	145
Warren	South West	Walpole fine grain mosaic burning trial	147
Goldfields, South Coast, Midwest, Wheatbelt, South West, Warren	Avon, Northern Agricultural, Rangelands, South West, South Coast	Genetic analysis for the development of vegetation services and sustainable environmental management	148
South West, Warren	Avon, South West	Identification of seed collection zones for rehabilitation	149
Midwest, Wheatbelt, South Coast	Avon, Northern Agricultural, South Coast	Management of weed risk in perennial landuse systems	150
Wheatbelt, Warren, South Coast	Avon, South Coast	Biology of the new psyllid *Cardiaspina jerramungae* in the lower great southern of WA on flat-topped yate	151
Warren	South Coast, South West	Quantitative population monitoring of gumleaf skeletonizer (GLS) *Uraba lugens*	152
Midwest, South Coast, Wheatbelt, South West, Swan, Warren	Avon, Northern Agricultural, South West, South Coast	State Salinity Strategy wetland monitoring	153
South West, Swan, Warren	Swan, South West, South Coast	Monitoring stream biodiversity (KPI 20 for Forest Management Plan)	155
Kimberley, Goldfields, Wheatbelt, Warren	Avon, Rangelands, South West	Bushfire CRC Project B1.4: Improved methods for the assessment and prediction of grassland curing	155
South Coast	South Coast	Effects of fire on plant species, communities and fauna habitat at Two Peoples Bay Nature Reserve	157
Wheatbelt	Avon	Effects of fire on plant species and communities at Tutanning Nature Reserve	158
Swan	South West, Swan	Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the jarrah forest	160
Kimberley, Pilbara, Goldfields, Midwest, South Coast, Wheatbelt	Rangelands	Directory of important wetlands in Australia: revised editions	160
South West	South West	Management of the Vasse - Wonnerup wetlands	162
Warren	South Coast, South West	Monitoring post-fire effects from the 2001 Nuyts wildfire	163
Warren	South West	Long-term monitoring of timber harvesting on bird populations in south-west forest areas	164
South West, Swan, Warren	South Coast, South West, Swan	Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest	165
Warren	South West	Increasing productivity of karri regrowth stands by thinning and fertilizing	166
South West	South West	Effect of fire on groundwater recharge to the Jewel Cave karst system	167

SUMMARY OF SIGNIFICANT ACHIEVEMENTS ANTICIPATED for 2007/08

ALIGNED WITH DEC's KEY RESULT AREAS

Key Result Area (KRA)	Anticipated achievements
KRA 1. Establishment of a comprehensive, adequate and representative (CAR) terrestrial and marine conservation reserve system	**Terrestrial biological survey**: Develop a 10 year plan for regional and sub-regional biological surveys. Publish the findings of the biological survey of the Pilbara Bioregion and make management recommendations; promote the survey findings and communicate results to key stakeholders. Commence the Kimberley islands biological survey. Complete analysis and write-up of some 8 sub-regional biological surveys. Complete floristic surveys of banded ironstone ranges in the goldfields and Ravensthorpe Range. Commence targeted survey of south-west forests region. **Marine biological survey**: Develop a 10 year plan for regional and sub-regional biological surveys. Commence planning and implementation of 2 regional marine surveys (South Coast & Kimberley). Commence targeted surveys of existing and proposed Marine Protected Areas (MPAs). **Information management**: Progress the development of biodiversity information management systems that provide extensive support for systematic biological inventory and decision-making including NatureBase and DEC's Perth Herbarium information systems including FloraBase. Commence the development of a consolidated biological survey information system (BioSIS). Finalize the Divisional metadatabase.
KRA 2. Maintenance of a terrestrial / marine protected area network (IUCN management categories I to VI)	**Introduced animals**: Continue investigations into meso-predator release and reasons for non-sustained fauna recovery in parts of the south-west covered by Western Shield. Continue with the expansion of introduced predator control programs, especially feral cat, into the semi-arid and arid zones. In collaboration with Goldfields Regional, continue broadscale feral predator control at Lorna Glen and progress with the reintroduction of native mammals. Continue with investigations into introduced predator control techniques in lower Murchison and Wheatbelt regions. Participate in cane toad monitoring, establishment of predation and diet trials. Continue program of feral camel survey/population benchmarking, monitoring impacts of feral goats, Kalbarri National Park, continue with feral camel DNA project with Murdoch University. Quantify environmental impacts of feral pigs in northern jarrah forest. With community and mining company support, continue with the introduced predator control (baiting) at Mt Manning Nature Reserve and monitor the response of mallee fowl populations (and other extant fauna). **Fire**: In collaboration with CSIRO, continue investigations into the role of fire in Kimberley ecosystems and commence investigations into fire-weed interactions in fragmented landscapes (wheatbelt and Swan Coastal Plain). Finalize data analysis and write-up of the Tutanning long term fire ecology sites. Continue with investigations into plant fire ecology in hummock grasslands. Continue the field program of Bushfire CRC-funded fire and biodiversity project to investigate fire effects in south-west ecosystems over 50 years. Continue to implement and monitor mosaic burn treatments, Walpole Fire Mosaic project. Publish long-term effects of fire regimes on jarrah forest tree health and growth. Maintain long term fire ecology research programs in SW forest ecosystems and hummock grasslands (both species specific and ecosystem levels); assess and analyse long term fire ecology plots in south-west forests. Draft revised fire behaviour model, dry sclerophyll forests, Project Vesta. Assist with the development of an adaptive fire management plan for Lesueur National Park. Develop fire management strategies for hummock grasslands, savannas and SW forests for biodiversity enhancement/protection. Assist with the development of Bioregional Fire Management Strategies and Regional Management Plans. **Disease**: Continue investigations into the effective use of phosphite to control the impacts of *Phytophthora cinnamomi*. Continue with the determination of the susceptibility of a range of threatened flora to *Phytophthora cinnamomi*. Assist with the development and implementation of an integrated *Phytophthora* dieback management and research program, including undertake a risk assessment program to determine impacts on biodiversity assets and prioritize abatement activities. Maintain monitoring of wandoo decline. Assist Tuart Response Group. Maintain watching brief Mundulla Yellows. Continue to investigate animal diseases – e.g., western barred bandicoot wart disease, potential role of disease in woylie decline. **Salinity**: Continue to provide support/advice/data to maintain and recover biodiversity with emphasis on recovery catchments under the State Salinity Strategy. Participate in NRM planning at State and Regional levels and to provide technical support/advice. Commence modelling impacts of climate change on communities and species at risk. **Terrestrial monitoring**: Develop a framework and protocols for State-level resource condition (vegetation) monitoring (NHT/NAP project). Continue to monitor wetlands as part of the State Salinity

Key Result Area (KRA)	Anticipated achievements
	Strategy. Other wetlands being monitored include Peel-Harvey Estuary (waterbirds), Vasse-Wonnerup. Reports produced, findings communicated to land managers and decision makers. Prepare revised edition of the WA chapter of National Directory of Important Wetlands, update the national database of Directory to include new sites and enhanced site descriptors. Participate in development of Rangelands monitoring protocol and establish base-line vegetation condition monitoring in the rangelands. Establish baseline ecosystem health monitoring with respect to climate change in vulnerable/wet SW ecosystems. Ongoing monitoring and reporting on forest vertebrates Perup), benthic invertebrate communities, mammals on Barrow Island, Bernier and Dorre Islands, wheatbelt wetlands, Vasse-Wonnerup wetlands, Peel-Harvey estuary waterbirds, rare arid zone dasyurids, wildfire impacts, previous translocations (bristle birds, ground parrots, numbats, chuditch, western ringtails, dibbler, western barred bandicoot, Shark Bay mouse. Develop protocol for monitoring rock-wallabies, sea turtles. Monitoring translocations of threatened flora. **Marine monitoring**: Review current and historical monitoring programs. Analyse and report on monitoring data for Jurien Bay Marine Park. Undertake a collaborative survey of the Rowley Shoals Marine Protected Areas (MPAs). Commence a program to develop a comprehensive map of the benthic habitats of the Montebello/Barrow Isl. MPAs. Establish baseline condition/health of major benthic communities in the proposed Dampier Archipelago/Cape Preston MPAs. Carry out the routine 3-yearly survey of Ningaloo *Drupella*. Continue to document the recovery of coral reef communities in Coral Bay. Assist Pilbara Region with the development of a sea turtle monitoring program. Map the coral reef communities of the Shark Bay Marine Park. **Information management**: Continue to develop a framework for managing (warehouse, disseminate, value add) critical biophysical information to support biodiversity conservation and decision making (NatureBank). Develop and maintain a Science Division meta-database. Develop a bibliography and metadatabase of marine science projects undertaken in tropical WA . Develop a WAMSI node 3 data management plan. Contribute to a review of corporate biological and land datasets, and to the development of a statewide database system to store and retrieve data and information.
KRA 3. Conservation of landscape /seascape scale ecological systems and processes (integrating reserve and off-reserve conservation)	**Technical support/advice**: Assist with the up-date of the WA Biodiversity Audit, including the progressive development of sub-regional case studies, and commencement of bioregional planning to determine key conservation priorities and knowledge gaps, to provide the basis for monitoring and evaluation of progress and effectiveness; Science Division staff will continue to provide support/advice to Natural Diversity Recovery Program - additional catchments, planning process for existing Natural Diversity Recovery Program and recovery catchments under the State Salinity Strategy. Science Division staff will continue to participate in NRM planning at State and Regional levels and to provide technical support/advice.
KRA 4. Recovery of threatened species and ecological communities and conservation and sustainable use of other significant species	**Threatened species**: Develop a research strategy for threatened species, including research priorities. Many projects are ongoing from previous years and include: Investigations to improve knowledge of the distribution, ecology, biology, monitoring and conservation status of threatened species as a basis for conservation/recovery actions, especially; Gilbert's potoroo, dibbler, red-tailed phascogale, brush-tailed phascogale, numbat, western swamp tortoise, western barred bandicoot, chuditch, bilby, western ringtail possum, heath mouse, marine turtles, pythons, Lancelin Isl. Skink, rock-wallabies, quokka, noisy scrub bird, western bristle bird, and critically endangered flora. Continue to investigate the cause of recent decline in woylie populations. Increase taxonomic effort to clear backlog of undescribed flora, including threatened and priority flora. Implement threatened flora translocation plans. Provide advice on the impacts of proposed mining operations on conservation values of flora and vegetation of the Goldfields and Swan Coastal Plain. Develop appropriate translocation techniques for a range of critically endangered flora and develop detailed protocols for assessing and predicting translocation success. Accurately assess the conservation status of Western Australian flora listed as poorly known but considered to be rare (DEC Priority Flora) and recommend additions to the list of Declared Rare Flora as necessary. 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. 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. Rank the ecological constraints to population growth in DRF (threatened) and provide management guidelines for use in recovery plans. Ongoing assessment of the conservation status of rare and poorly known flora thought to be critically endangered (130 taxa). Gain an understanding of the reproductive biology & demography of rare *Tetratheca* impacted by mining. Continue reassessment of conservation status of WA Acacias. Continue major project to elucidate variation in mulga, a keystone rangelands taxon. Experimental fauna translocations proposed include bilby and brushtail possum to Lorna Glen pending success of introduced predator trials. Develop appropriate translocation techniques for a range of critically endangered flora and develop detailed protocols for assessing and predicting translocation success. Continue experimental translocations of 21 critically endangered flora. **Recovery and management plans**: Revise numbat RP, revise chuditch RP, review status rock wallabies and prepare recovery plan, complete red-tailed phascogale RP, assist with fire management plan Two People's Bay and Mt Manypeaks and with Regional and area-based fire management plans, assist with post-wildfire monitoring Mt Manypeaks, assist with hummock grasslands fire management plan. Continue to assist with captive breeding including Return to Dryandra, Gilbert's potoroo, cross-fostering trial Gilbert's potoroo. Analyse and write up results of Kimberley mammal survey, sub-fossil survey. **Genetics**: Develop a plan for molecular genetics surveys and research and for collecting and storing

Key Result Area (KRA)	Anticipated achievements
	tissue from threatened taxa for DNA analysis. Provide genetic and phylogenetic information for the conservation, circumscription and management of Western Australian flora, particularly Declared Rare Flora and Priority Flora. Determine the phylogenetic relationships between geographically diverse populations and patterns of genetic diversity in Declared Rare Flora, Priority Flora and other species of conservation significance. Identify and quantify the genetic and demographic factors that affect the viability of plant populations in vegetation remnants. Provide a cost effective and efficient interim solution to loss of native plant genetic diversity and a focus for flora recovery in Western Australia by collection and storage of seed from rare and threatened Western Australian plant species. **Weeds**: Continue to provide advice on weed identification and control strategies. Convene a workshop to progress a regional weed risk analysis framework. Assist with the documentation of the occurrence, impact and control of environmental weeds of Western Australia and to assist in prioritizing management of weeds at a local, State and federal level. Identification of weed and native species in threatened ecological communities. **Sustainable Forest Management**: Assist with reviews, provide technical advice as and when required. Maintain FORESTCHECK, an integrated monitoring system that has been developed to provide information to forest managers in the south-west of Western Australia about changes and trends in key elements of forest biodiversity associated with a variety of forest management activities. Complete write-up of five-year major review of FORESTCHECK. Complete investigation the effects of logging and the associated burning operations on the terrestrial invertebrate fauna inhabiting medium rainfall jarrah forest (particularly spiders, beetles and flies). Complete investigations into the ecological impacts of logging and associated burning operations on populations of medium-sized mammals inhabiting medium rainfall jarrah forest. Continue to monitor the effects of timber harvesting on bird species/community composition in the karri forest. Document the effects of topography on distribution and abundance of invertebrates in jarrah forest. Identify appropriate seed collection zones for vascular plants used in rehabilitation of sites disturbed during forest operations. To understand the fundamental processes of seed cycle, regeneration, competition and stand dynamics of jarrah forest on a range of sites as a basis for developing silvicultural practices to achieve a range of ESFM outcomes. Complete paper on forest health monitoring. Continue monitoring run-off and groundwater in response to logging in IRZ – prepare report. Continue to implement monitoring of forest stream biodiversity and water quality.
KRA 5. Providing for sustainable nature-based recreation and tourism and increased enjoyment and appreciation of protected areas	Commence a process to integrate social and biolo gical sciences. Collaborate with Parks and Visitor Services Division in the delivery of research programs that relate to the interaction of people with the natural environment. Provide technical and scientific input to management plans, provide plant names to support information booklets (e.g. Bush books), 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 and 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	Ongoing program of workshops, seminars and public meetings. Development of publicly accessible biodiversity information management systems (NatureBank). Landscope expeditions throughout WA. Landscope and other popular 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. Regional Herbaria and Weed Information Network projects; DEC 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.

KEY STRATEGIC ASPIRATIONAL GOALS AND ACTIONS

2008-2017

G1 Understand the composition of, and patterning in, terrestrial and marine biodiversity

Within 5 years

State scale

1.1 Develop 10 year plans for terrestrial and marine biological survey of WA.

1.2 Develop a consolidated biological survey information management system (BioSIS) that incorporates data collected from past surveys and which will incorporate data from future surveys.

1.3 Complete an electronic Flora of Western Australia, collating existing taxonomic information on plants, algae and fungi.

Bioregional scale

1.4 Complete the Pilbara regional survey.

1.5 Complete the South Coast and Kimberley regional marine biodiversity surveys.

1.6 Commence another bioregional terrestrial survey consistent with 1.1 above.

Sub-regional scale

1.7 Prepare a 10 year plan for sub-regional terrestrial and marine surveys including targeted ecosystems and conservation reserves.

1.8 Complete the Kimberley islands survey.

1.9 Complete the targeted south-west forests survey.

1.10 Complete the banded ironstone formations floristic surveys.

1.11 Complete the Ravensthorpe Range floristic and short range endemic invertebrate survey.

1.12 Compile all existing biological data for the DEC conservation reserve estate into a readily accessible database.

Species/population scale

1.13 Prepare and implement a plan for resolving the taxonomy of all undescribed terrestrial plants.

1.14 Describe marine plants collected in association with research, survey and monitoring.

1.15 Continue collections and descriptions of fungi and invertebrates in association with research, survey and monitoring.

1.16 Develop and implement a plan for molecular genetics research and surveys to address priorities in systematics, phylogeography, ecosystem processes (gene flow) and conservation genetics.

1.17 Develop and implement a plan for collecting and storing listed threatened flora and fauna tissue for DNA extraction and DNA banking as a basis for characterizing genetic diversity and for assisting with taxonomic studies and translocations.

Within 10 years

State & bioregional scale

1.18 Complete systematic regional biological survey of 50% of WA's terrestrial and 20% of marine areas.

1.19 Prepare ecosystem/vegetation maps at 1:100 000 scale for protected areas in WA.

Sub-regional scale

1.20 Complete 3 additional sub-regional/targeted surveys consistent with action 1.1 above.

1.21 Complete 7 targeted surveys of existing/proposed marine protected areas consistent with action 1.1 above.

1.22 Complete floristic surveys of an additional 20 terrestrial priority conservation reserves.

Species/population scale

1.23 Describe 500 new terrestrial plant species and 100 new marine plant species.

1.24 Complete the development of a biodiversity information management system.

1.25 Collect and store flora and fauna (including invertebrates) tissue for DNA extraction of targeted/keystone species collected during biological surveys as a basis for understanding genetic diversity and how well it is represented in the conservation reserve system.

1.26 Collect and store tissue of threatened taxa for DNA extraction as a basis for taxonomic studies and for conservation of genetic variability.

1.27 Establish a DNA bank based on targeted/keystone flora and fauna material collected during biological

surveys and from listed threatened taxa.

G 2 Understand the threats to biodiversity and develop evidence-based management options to ameliorate threats

Within 5 years

Threatened species and communities

2.1 Undertake the research needed to resolve the conservation status of listed threatened and Priority species and ecological communities.

2.2 Develop and implement a research strategy, including identifying research priorities, for threatened fauna, flora and ecological communities as a basis for threat amelioration and development and implementation of prioritized recovery plans/actions.

2.3 Undertake research to improve understanding of the conservation status of invertebrates.

2.4 Continue to implement necessary research and recovery actions for Gilbert's Potoroo (*Potorous gilbertii*), Australia's rarest mammal.

2.5 Assist with the revision the strategic plan for the Western Shield fauna conservation program and undertake the necessary research to underpin the plan (links with 2.2).

2.6 Participate in active adaptive management programs that will lead to improved conservation status of threatened arid zone medium size mammals (links with 2.2), a group that has declined significantly since European settlement.

2.7 Undertake a state-wide risk analysis of biodiversity threats and likely impacted species and communities to complement the biodiversity audit. Continue to develop the biodiversity audit for WA.

2.8 Continue to develop and implement an adaptive management approach to the translocation of threatened flora and establish a threatened flora translocation database.

Threatening processes

2.9 Develop an understanding of climate change impacts on potentially 'at risk' species, communities and ecosystems as a basis for developing management response options.

2.10 Develop and implement a program to monitor climate change effects on biodiversity in targeted terrestrial and marine areas.

2.11 Develop risk assessment methods to anticipate and communicate long term issues that are likely to threaten biodiversity over the next 10 years and longer (links with 2.7).

2.12 Complete research into interactions between fire and weeds in fragmented landscapes.

2.13 Develop an understanding of the influence of buffel grass (*Cenchrus ciliaris*) on rangelands ecosystems as a basis for risk assessment and management response options.

2.14 Continue research into the role of fire in ecosystems, including understanding ecological responses, carbon flux and green house gas emissions of various fire regimes in the North Kimberley, Pilbara, Coolgardie and Desert bioregions.

2.15 Continue with long term fire regime research in south-west ecosystems as a basis for developing ecologically appropriate fire management in a global biodiversity hotspot.

2.16 Develop an understanding of the influence of climate change on fire regimes and ecosystem response in south-west ecosystems as a basis for developing management response options.

2.17 Determine the distribution and abundance of feral camels, goats, pigs and invasive birds and investigate/document their impacts on biodiversity as a basis for developing effective control strategies.

2.18 Complete research into mesopredator interactions as a basis for the sustained recovery of native fauna.

2.19 Complete research into sustained, effective control of feral cats across a range of biomes.

2.20 Develop an understanding of the distribution and impacts of cane toads on native fauna as a basis for developing management response options.

2.21 Determine the distribution of *Phytophthora cinnamomi*, undertake a risk analysis of the threat it poses to biodiversity and continue to develop techniques for managing the threat.

2.22 Undertake risk analysis of biodiversity threats posed by environmental weeds at the species and ecosystem levels and prepare a strategic plan for priority weed control and restoration research.

2.23 Commence investigations into the impacts of recreation and tourism on high priority conservation values and listed threatened species.

2.24 Undertake an analysis of the critical research issues associated with the potential impacts of water extraction from major aquifers on biodiversity values.

2.25 Assist with the development and implementation of an ecological restoration framework for the Gnangara water mound.

Within 10 years

Threatened species and communities

2.26 Conduct priority research on threatened communities as a basis for understanding and managing threatening processes (consistent with 2.2).

2.27 Understand key ecological processes of small threatened plant populations as a basis for their conservation management.

2.28 Conduct necessary research to improve the conservation status of listed threatened fauna especially taxa that were once widespread on the mainland but are now restricted to islands.

2.29 Conduct research to improve the conservation status of species of listed threatened flora, especially Critically Endangered taxa (consistent with 2.2).
2.30 Double the population of Gilbert's Potoroo relative to the 2007 baseline.
2.31 In an adaptive management framework, establish translocations for 66% of Critically Endangered flora and finalize procedures for assessing translocation success for all threatened flora translocations.

Threatening processes
2.32 Develop safe and effective control technologies for feral cats, camels, goats and pigs on DEC managed lands.
2.33 Develop management response options for species and ecosystems 'at risk' from climate change.
2.34 Develop technologies for the containment of *Phytophthora cinnamomi* outbreaks in high priority (high conservation value) areas, e.g., Fitzgerald River National Park.
2.35 Understand the cause(s) of decline of Kimberley mammal fauna as a basis for appropriate management actions to reverse declines.
2.36 Develop an understanding of fire ecology, including carbon fluxes and green house gas emissions, of fire regimes in Mallee, Geraldton Sandplains and Esperance bioregions as a basis for ecologically sustainable fire management.
2.37 Understand the impacts of water extraction from the major aquifers on key species and ecosystems as a basis for advising on sustainable extraction levels.
2.38 Understand ecosystem dynamics at landscape scales, including interactions between threatening and other ecological processes (such as fire and weeds), especially in highly fragmented landscapes.

G 3 Monitor and evaluate the condition and trends of species, populations and communities in terrestrial and marine ecosystems

Within 5 years
3.1 Provide the scientific basis for, and assist with, the development of cost effective protocols for monitoring resource condition at various scales (landscape, ecosystem, protected area and species).
3.2 Establish climate change monitoring protocols and priorities for 'at risk' species, communities and ecosystems.
3.3 Implement targeted monitoring to assess the impacts of cane toads on native fauna.
3.4 Develop and assist with the implementation of protocols for monitoring the density, distribution and the effectiveness of control programs of large feral herbivores especially feral goats and camels.
3.5 Develop and assist with the implementation of protocols for monitoring the response of species and ecosystems to managed fire regimes.
3.6 Complete and publish a five year review of the FORESTCHECK forest monitoring protocol.

Within 10 years
3.7 Assist with the implementation of cost effective protocols for monitoring resource condition at various scales (landscape, ecosystem, protected area and species). Links with 3.1.
3.8 Establish scientifically sound protocols and assist with the implementation of marine resource condition monitoring for all marine parks and reserves including sanctuary zones, threatened marine fauna, significant marine ecosystems and other benchmark areas.
3.9 Assist with the development of corporate monitoring data and information systems.

G 4 Provide scientific concepts and tools for best practice management of biodiversity as an integral part of natural resource management

Within 5 years
4.1 Assist with the development of a framework for designing a terrestrial CAR reserve system.
4.2 Develop/design tools and protocols for the establishment and management of a CAR network of marine protected areas (including marine sanctuary zones).
4.3 Complete investigations into the effects of timber harvesting activities on forest ecosystems and ecosystem processes consistent with the Forest Management Plan 2004-2013.
4.4 Devise, establish and implement a Forest Health Surveillance system for Western Australian forests consistent with the Forest Management Plan 2004-2013.
4.5 Assist in the development of a conservation reserve biological database to support reserve management.
4.6 Assist with refining technical protocols for listing and de-listing Priority taxa and threatened ecological communities.
4.7 Continue the development of the WA Biodiversity audit.
4.8 Develop tools and protocols for implementing active adaptive management programs.
4.9 Continue to contribute to the development of policies, prescriptions, management plans and management guidelines.
4.10 Continue to provide scientific advice to other DEC Divisions, government agencies and regulatory authorities on natural resource management and environmental impact assessment.

G 5 Improve knowledge of how people respond to, and interact with, the natural environment including protected areas and threatened species

Within 5 years

5.1 Integrate social and biological sciences in investigations into visitor usage and impacts in collaboration with Parks and Visitor Services Division.

5.2 Collaborate with Parks and Visitor Services Division and external research providers in the delivery of research programs that relate to the interaction of people with the natural environment including protected areas and threatened species.

Within 10 years

5.2 Implement research programs on the biology and behaviour of key species and communities that are subjected to recreation and tourism interaction as a basis for minimizing adverse impacts.

5.3 Implement research programs to understand visitor use patterns, levels of visitor satisfaction, visitor expectations and behaviours in the natural environment.

5.4 Develop environmental indicators for sustainable tourism.

5.5 Understand community attitudes and perceptions, including those of Indigenous communities, about the environment, biodiversity conservation and DEC's policies and operations, as a basis for developing policies and programs aimed at gaining community support for conservation management actions on and off protected areas.

5.6 Develop models for community engagement in conservation management and recreation and tourism planning.

5.7 Undertake research to better understand the social, environmental and economic aspirations of traditional owners connected with, or that have an association with, particular protected areas.

G 6 Promote and facilitate the uptake of research findings and communicate the contribution of science to biodiversity conservation and natural resource management

Within 5 years

6.1 Appoint a Science Communications Officer and prepare and implement a science communications plan.

6.2 Develop a Departmental Science Policy.

6.3 Increase the output of high quality scientific papers, management guidelines and popular articles, and participation in and initiation of seminars, conferences and field days.

6.4 Develop tools and technical protocols for implementing active adaptive management programs as a mechanism for corporate learning. Implement at least 9 active adaptive management programs in partnership with other DEC Divisions (links with 4.6).

6.5 Continue to provide high level advice and input to international, national and state committees.

Within 10 years

6.6 Ensure that key scientific findings are incorporated into policies and practices.

6.7 Ensure that all science done by the Division, and other science relevant to the Department's charter, is successfully communicated to appropriate audiences by a variety of mechanisms.

6.8 Participate in thirty large scale active adaptive management programs delivering conservation outcomes and advances in knowledge.

RESEARCH ACTIVITY

BIOGEOGRAPHY

Program Leader: **Norm McKenzie (July 2006 to January 2007)**
Stephen van Leeuwen (January 2007 to June 2007)

Pilbara regional biological survey

SPP # 2002/04; 2004/002

Team members

N McKenzie (0.60), S Halse (0.5), AH Burbidge (0.8), S van Leeuwen (0.8), N Gibson (0.3), G Keighery (0.2), L Gibson (0.7), M Lyons (0.6), D Pearson (0.2), A Pinder (1.0), N Guthrie (1.0), B Durrant (1.0), J Rolfe (1.0), M Langley (0.5), J McRae (1.0), J Cocking (0.6) M Scanlon (0.5), H Barron (0.4), I Stratford (0.3), Regional assistance - P Kendrick (0.1) ; Total DEC 12.1.

Context

The Pilbara is an economically important region of WA, with major and expanding mineral extraction industries, pastoral industries, etc. Effective biodiversity conservation is needed to minimize the adverse impacts of these activities. The survey addresses problems of incomplete knowledge of biodiversity (composition, patterns, status, trend) for nature conservation planning, including reserve system gaps and weed invasions. Sampling includes reptiles, frogs, small ground mammals, bats, birds, arachnids, beetles, ants and aquatic invertebrates including stygofauna, wetland, terrestrial flora and soils to overcome low cross-taxon congruence in biodiversity models. Sampling covers a range of life-history strategies, motilities, ecological roles, longevities, parts of phylogenetic tree, etc. Geomorphic and geographical coverage using c. 800 quadrats; 2 seasons from fully overlapped sampling in 2 different 12 month periods.

Aim

To provide a regional perspective on biodiversity and nature conservation priorities, provide data on the distribution of the biota, identify gradients in community composition and the environmental factors related to these gradients, and complement site-specific studies being undertaken by mining companies and others.

Summary of progress and main findings

- Vertebrate sampling complete for all 304 terrestrial sites.
- Botanical sampling completed of 304 terrestrial sites and an additional 104 botanical sites.
- Non-volant mammal and bat identifications completed and species x site matrix compiled.
- Botanical specimens sorting and identification commenced.
- Sorting of all terrestrial invertebrate samples completed.
- Preliminary identifications completed for reptiles and amphibians.
- Coleoptera and Araneae family sorting and species identification underway.
- Weevils and Scaraboids sent to the ANIC for identification, several other taxa sent to specialists (USA, Germany).
- All aquatic field work completed.
- All aquatic invertebrate samples sorted and 90% identifications complete.
- Aquatic vascular botanical specimen identifications 25% complete. Algal identifications (macrophyte and planktonic) completed.
- All stygofauna field work completed.
- Several taxonomic revisions of stygofauna taxa published.

- All stygofauna specimens identified and matrix compiled for analysis.
- Numerous local, state and national presentations and advice on progress of survey.

Management implications

- Basis for systematic regional nature conservation planning for reserve system development, and distribution and conservation status of species (indigenous and weeds) and ecological communities.
- Long-term ecological monitoring of region.

Future directions (next 12-18 months)

- Sort and identify ~30 000 plant vouchers.
- Finalize identification of terrestrial invertebrates, including 25 000+ Coleoptera and 20,000+ specimens.
- Vouchers of all terrestrial invertebrate specimens sent to WA Museum.
- Compile aquatic zoology site x taxon matrices, undertake analyses and write aquatic zoology papers.
- Prepare terrestrial zoology site x taxon matrices, undertake and interpret analyses and write relevant papers.
- Prepare aquatic flora site x taxon matrix, analyse and interpret it, then write relevant paper.
- Prepare terrestrial flora site x taxon matrix, undertake and interpret analysis and write terrestrial flora paper.
- Compile terrestrial plant and zoological data-sets, then analyse, interpret and write community paper.
- Compile Pilbara Biological Survey report and submit for publication.
- Present Pilbara Biodiversity Symposium in conjunction with Royal Society of WA.
- Undertake Pilbara Biodiversity Road show tour throughout the Pilbara.
- In collaboration with Plant Sciences University of Western Australia and with funding from Rio Tinto Iron Ore commence Pilbara vegetation water use study.

DEC Region
Pilbara.

IBRA Region
Pilbara.

NRM Region
Rangelands.

Kimberley islands biological survey

SPP # 2007/0001

Team members

A Start (0.85), McKenzie (0.10), G Keighery (0.15), L Gibson (0.3) R Palmer (1.0), B Muir (0.4) A Burbidge (External); Total DEC 2.80.

Context

Archipelagoes along the Kimberley coast present an opportunity to conserve intact examples of ecosystems that have been modified or affected by various threatening processes on the mainland. Knowledge is rudimentary about island distributions of species and ecological communities, including those that are endemic to the Kimberley and those that are threatened on the mainland. A comprehensive biological survey of the islands off the North Kimberley coast is required. This survey

will focus on sampling vertebrate and selected groups of invertebrate fauna that are most likely to be affected by the cane toad as well as by other mainland changes. It will also sample their flora, soil and other environmental attributes that are indicators of biogeographical patterning, environmental health, and provide a basis for monitoring.

Aim

To provide the knowledge base that will enable better decision-making for conservation given the imminent arrival of the cane toad on the adjacent mainland and potentially on some of the islands, also for use in the consideration of development projects by industry and to provide information for community-based natural resource management and biodiversity planning.

Summary of progress and main findings

- DEC project description submitted to Director of Science Division, DEC.
- Animal Ethics application approved.
- Helicopter logistics completed and charter awarded.
- Presentation delivered to the Kimberley Land Council and Regional DEC staff in Broome.
- Meeting with the Kimberley Land Council in February 2007 in Broome where negotiations commenced regarding involvement of Traditional Owners.
- Preliminary site selection on islands completed via aerial inspection.
- Complementary mainland Kimberley survey of amphibians by WA Museum completed (includes WA Museum staff specifically involved in island survey).

Management implications

- Basis for systematic foundation supporting nature conservation planning for reserve system development, and distribution and conservation status of species (indigenous and weeds) and ecological communities.
- Long-term ecological monitoring of region.

Future directions (next 12-18 months)

- Conduct first dry season survey (on Bigge, Boongaree, Katers, Middle Osborne, SW Osborne and Sir Graham Moore Islands).
- Complete vertebrate and plant identifications from above islands.
- Conduct wet season amphibian survey and identifications.
- Conduct second dry season survey (on Augustus, Champagny, Darcy, Uwins, Coronation and St Andrew Islands).

DEC Region

Kimberley.

IBRA Regions

Victoria Bonaparte, North Kimberley, Dampierland.

NRM Region

Rangelands.

Floristic survey of the banded ironstone formations (BIF) and greenstone ranges of the Yilgarn and Ravensthorpe Range

SPP # 93/0166 (New SPPs in preparation)

Team members

N Gibson (0.25), A Markey (1.0), R Meissner (1.0), S Dillon (1.0), Y Caruso/G Owens (1.0); Total

DEC 4.25.

Context

To assess the conservation significance of the flora and vegetation of the goldfields ranges, which are little studied and under increasing pressure from the rapidly expanding iron ore mining interests south of the Pilbara. This increase in interest is driven by the rapidly expanding Chinese market for iron ore.

Aim

To undertake a detailed floristic survey of the banded ironstone and greenstone woodlands of the Yilgarn to identify gaps in the present reserve network and to determine areas of high biological significance. This land system is poorly reserved and poorly documented while being highly prospective for mineral exploration.

Summary of progress and main findings

- Five draft papers on Banded Ironstone Formation survey resulted released.
- 303 quadrats sampled in 2006.
- Five finalized Banded Ironstone Formation datasets released.
- Contributed to Section 16 advice on Mt Manning area.
- Contributed to DEC's Banded Ironstone Formation strategic review.
- Two presentations at Conservation Council Banded Ironstone Formation symposium.
- Ongoing advice to managers.
- Ongoing advice to DEC's Species and Communities Branch.
- Ongoing advice to DEC's Environmental Management Branch on impacts of proposed developments.
- Ongoing advice to SOS (BCI) taxonomists at the WA Herbarium (Perth).

Management implications

- Provide regional context for the assessment of the impacts of proposed developments on conservation values on flora and vegetation of these ranges.

Future directions (next 12-18 months)

- Analyse and produce Year 2 Banded Ironstone Formation report.
- Undertake 3rd season (Spring 07) Banded Ironstone Formation sampling (300 quadrats)
- Analyse & produce Year 3 Banded Ironstone Formation report
- Consultants to continue flora & vegetation sampling in Ravensthorpe Range
- Consultants to continue Short-Range Endemic invert sampling in Ravensthorpe Range

DEC Regions

Goldfields, Midwest, South Coast.

IBRA Regions

Murchison, Avon Wheatbelt, Esperance Plains, Yalgoo.

NRM Region

Rangelands, Northern Agricultural, South Coast.

Biological survey of the agricultural zone (SAP Survey)

SPP # 98/0020

Team member
G Keighery (0.20).

Context
The south-west Western Australian agricultural zone is a degrading hotspot needing optimised conservation strategies. An ALTERM survey (mixed-taxon species lists from quadrats) was necessary to provide the first quantitative biodiversity model for whole region for focusing and optimising management strategies. Sampling included reptiles, frogs, small ground mammals, arachnids, aquatic invertebrates, wetland birds, wetland flora, terrestrial flora and soils to overcome low cross-taxon congruence in biodiversity. Sampling also covered a range of life-history strategies, motilities, ecological roles, longevities, different parts of phylogenetic tree, etc. Geomorphic and geographical coverage using ca. 932 quadrats; sampled in at least 2 seasons.

Aims
- To identify and prioritize recovery catchments, with respect to nature conservation values.
- To provide a regional perspective on nature conservation priorities to help determine and prioritize management actions particularly in relation to salinity.
- To provide baseline data for monitoring.
- To assist in provision of lists of plant species useful for revegetation and liaise with groups undertaking revegetation of the area.

Summary of progress and main findings
- Despite degradation, the SW Wheatbelt region retains high biodiversity values that require protection from threatening processes including salinity and water logging.
- Results provided to DEC managers and the broader community.
- Liaison on SAP survey communication
- Prepare revisions of wheatbelt *Frankenia* and *Triglochin*, and descriptions of new plant taxa.

Management implications
- Basis for systematic regional nature conservation planning for salinity, reserve system development, and distribution and conservation status of species (indigenous and weeds) and ecological communities, especially in relation to salinity futuring.
- A basis for long-term ecological monitoring of region's biodiversity.

Future directions (next 12-18 months)
- Liaison on SAP survey communication.

DEC Regions
Wheatbelt, South Coast, Midwest, Northern Forest, Southern Forest.

IBRA Regions
Geraldton Sandplains, Avon Wheatbelt, Jarrah Forest, Mallee, Esperance Plains.

NRM Regions
Avon, South West, Northern Agricultural, Rangelands.

Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain
SPP # 93/0038 (New SPP for Swan BioPlan project in preparation)

Team members
G Keighery (0.25), N Gibson (0.10); Total (0.25).

Context

The Swan Coastal Plain is highly fragmented and impacted by settlement, urbanisation and industry. Data at various levels is required to make decisions about the conservation and protection of biodiversity. This project to delivers data from Swan Coastal Plain Floristic and Reserve Survey to Swan Region NRM and Local Government.

Aim

To undertake studies into the classification, distribution, patterning and conservation status of vascular plant communities and taxa of the Swan Coastal Plain at a local and regional level. This will result in the preparation of flora lists for the region and conservation reserves. Elucidation of taxonomy of significant flora will occur as part of this process.

Summary of progress and main findings

- Numerous presentations.
- Conservation Commission advice on significant forest flora, Whicher Range National Park prepared.
- Participate in Perth Biodiversity Project (NRM) and Regional Parks Management Plan group.
- Advice to WA Threatened Species and Communities Unit (DEC).
- Published taxonomic paper.
- Reserve flora checklist papers for Ridge Hill Shelf prepared.

Management implications

- The basis for land use planning for biodiversity conservation on the swan coastal plain.

Future directions (next 12-18 months)

- Conclude Perth Biodiversity Project (Signed contract (details with Joanne Smith), involves WALGA, DPI and DEC.
- Data analysis and draft papers to transfer information in survey reports into scientific literature to assist land use planning decisions.
- Contribute data and expertise to Swan Bioplan (DPI and DEC) project 2004-2007. Use SCP checklist and field studies to commence updating vascular flora reservation status and reserve lists.
- Science Division representative on Swan Bioplan.
- Prepare concept plan & SPP for Whicher Range Floristics and Swan Bioplan project.
- Complete the floristic survey of the Whicher Scarp and Dandaragan Plateau, then analyse data.
- Continue to prepare and publish taxonomic papers publisher.

DEC Regions

Swan, South West.

IBRA Region

Swan Coastal Plain.

NRM Regions

Swan, South West.

Ecomorphological clues to community structure, bat echolocation studies

SPP # 93/0028

Team members

N McKenzie (0.10), R Bullen (External); Total (0.10).

Context

This currently underpins a component of the Pilbara Survey sampling program (see above).

Aims

- To extend the strategies and sampling methods used in wildlife surveys. If ecological surveys include a wider range of taxa, their results represent more of the ecological network. Guild studies such as these extend our knowledge of the assemblage structuring processes (including disturbances) that affect the composition and richness of Western Australian communities.
- To compile a dictionary of sonar signatures for automatically recording the composition of bat assemblages on quadrats.
- To develop ecomorphological measures of potential niche. Relate them to community structuring mechanisms and species' realized foraging niches.
- To inter-relate disturbance and structural determinism in bat communities.
- To investigate environmental factors controlling the occurrence of bats.

Summary of progress and main findings

- Submit paper for publication on bat aerodynamic cleanliness in context of difference in species foraging strategies.
- Submit paper for publication on aerodynamic cleanliness of bat fur in context of difference in species foraging strategies.
- Collect a reference library of echolocation calls for the 16 Pilbara microbat species, and identify echolocation calls from the 24 survey areas sampled during the Pilbara Biological Survey.
- Collect and compile data on flight capabilities, foraging strategies and microhabitats of all Pilbara bats.

Management implications

- More biodiverse surveys, better understanding of guild and fauna structure in WA ecological communities. Understanding their distributions and status for nature conservation.

Future directions (next 12-18 months)

- Publish paper on aerodynamic cleanliness of bat wings in context of differences in species foraging strategies.
- Publish paper on aerodynamic cleanliness of bat fur in context of difference in species foraging strategies.
- Write and submit papers for publication on identifying Pilbara bats from their echolocation calls, and on the foraging ecology of the Pilbara bats and structure of this fauna.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Conservation of Western Australia's vegetation assemblages

SPP # 94//0003

Interim framework for developing a CAR reserve system for WA

SPP # 2000//0011

Land-use and vegetation mapping

SPP # 2000/0010

Identifying land with high nature conservation values in the Gascoyne Murchison strategy area

SPP # 2000/0009

Team member

A Hopkins (0.20).

Context

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

Aims

- To produce a framework for in-situ nature conservation in Western Australia. This will be achieved via a State-wide database which brings together information about ecosystems and ecological communities within the State, threats to the nature conservation values of each, and land use data, for the purposes of bioregional planning. The database and associated GIS can then be used to develop priorities for land acquisition and off-reserve management agreements and indigenous protected areas.
- To produce a series of map products and associated databases covering the State to pre-agreed specifications for the themes land-use, pre-European vegetation type and extent, present type and extent and vegetation condition. In addition, we will develop a database of metadata of vegetation survey datasets.

Summary of progress and main findings

- Training for Midwest Regional staff in vegetation sampling, mapping, attribution for the Living Treasures project.
- Training and support for Avon NRM regional project staff.
- Analyses of pastoral leases proposed for acquisition.

Management implications

- Broadscale planning of nature conservation output needs e.g. reserve system design and acquisition.

Future directions (next 12-18 months)

- Finalization of database on pre-European vegetation of Western Australia.
- Continued liaison with DEC's GIS Branch and Department of Agriculture & Food on aspects of pre-European vegetation dataset.
- Work with staff at Department of Agriculture & Food, DEC's SFMB to upgrade mapping over the jarrah forest IBRA Region and adjacent Bioregions
- Prepare a 1:1,000,000 map product of the South West Botanical Region for publication by University of Western Australia Press (to replace the 1:1,000,000 Swan Sheet).
- Continued cooperation with Tony Brandis to support the land acquisition program across the rangelands by developing and providing supporting documentation.

DEC Regions

All.

IBRA Regions
All.

NRM Regions
All.

Biodiversity audit
Core Function - Policy

Team members
N McKenzie (0.20), AA Burbidge(0.10) (External); Total (0.30).

Context
A review to underpin nature conservation planning in WA as part of an Australia-wide process. Used in WA for assessing priorities among alternative nature conservation activities in different IBRA subregions, and as a one-stop reference source for regional NRM groups.

Aim
To audit WA biodiversity and conservation activities as part of NLWRA program, producing IBRA sub-regional synopses, IBRA bioregional summaries, case studies for 2 sub-regions, and analysis of mammal, Acacia, eucalypt and bird status by bioregion.

Summary of progress and main findings
- Member of Nature Conservation Output Working Group.
- Manuscript reporting findings of mammal audit completed.
- Present Audit mammal analysis results at Australian Mammalogy Society meeting.
- 14 species accounts published in the revised edition of 'Mammals of Australia'.
- Final sub-fossil mammal identifications for Napier-Oscar Ranges from M McDowell and A Baynes.
- Presentation of Audit mammal analysis at Australian Mammal Society conference.
- Mammal decline paper published (*Journal of Biogeography*).
- First Kimberley mammal audit paper accepted for publication.

Management implications
- A basis for systematic regional nature conservation planning and delivery.

Future directions (next 12-18 months)
- Write and submit second of 2 papers reporting Kimberley mammal audit results for publication.
- Mammal audit data base updated and submitted for publication, including a quantitative analysis of the biogeography of Australia's original mammal fauna.
- Investigate assessment of the mammal audit data-set in the context of climate-change predictions.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

National reserve system working group

Core Function - Policy

Team member

N McKenzie (0.05).

Context

The Reserve system is Australia's primary nature conservation strategy. The establishment of the National Reserve System (NRS) program under the Natural Heritage Trust meets the requirement under the National Strategy for the Conservation of Australia's Biological Diversity to establish a comprehensive, adequate and representative system of terrestrial protected areas. There is a separate program to establish marine protected areas.

Aims

- To establish and manage new ecologically significant protected areas for addition to Australia's terrestrial National Reserve System.
- To provide incentives for Indigenous people to participate in the National Reserve System through voluntary declaration of protected areas on their lands and support for greater involvement of indigenous people in the management of existing statutory protected areas.
- To provide incentives for landholders (both private landholders and leaseholders) to strategically enhance the National Reserve System.
- To develop and implement best practice standards for the management of Australia's National Reserve System Systematic development of a secure CAR reserve system for Australia that meets national and international standards.
- To develop and continue to refine the 'Interim Biogeographical Regionalisation of Australia'

Summary of progress and main findings

- No policy publications since IBRA ver. 6 was released in March 2005, and the NRS Directions Statement was released in November 2005.

Management implications

- Reserve system development, management and standards.

Future directions (next 12-18 months)

- Development and release of IBRA version 7.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Provision of biogeographical information for DEC management plans, NRM advice scientific liaison and membership of scientific advisory committees

Core Function - Policy

Team member

G Keighery (0.05).

Context

Provision of vascular flora data for NRM activities, DEC nature conservation planning and operations in WA.

Aim

To liaise with and advise managers, planners, NRM groups on the identification and protection of flora biodiversity assets.

Summary of progress and main findings

- Paper on floras of 34 island nature reserves of Shark Bay submitted.
- Submit papers on flora of Margaret Plateau parks.

Management implications

- Scientific basis of effective nature conservation.

Future directions (next 12-18 months)

- Give scientific advice in Shark Bay World Heritage committee and RIEAC.
- Represent Science Division in Regional Parks management planning teams, SCRIPT biodiversity planning.
- Provide scientific advice on SW biodiversity hotspots NRM project.
- Provide scientific advice to WA Threatened Species and Communities Unit's scientific advisory committee.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

De-commission the Pilbara Regional Herbarium

Core Function

Team members

S van Leeuwen (0.15), B Bromilow (0.2); Total (0.35).

Context

With the absence of Science Division staff in Karratha, the ~12 000 vouchers in the Pilbara Regional Herbarium (PRH/KARR) collection were threatened with falling into neglect and becoming worthless through curatorial redundancy, insect damage and fungal attack. To ensure the integrity of the collection (including TYPES) the vouchers were forwarded to the Western Australia Herbarium (Perth) for retention and duplicates distribution as necessary and appropriate. A comprehensive public reference collection would be created and retained in Karratha.

Aims

The objective of this task was to ensure that vouchers within the Pilbara Regional Herbarium were distributed to the most appropriate Australian Herbaria to ensure that maximum value could be achieved for the collection. The voucher distribution protocol aimed to ensure firstly, that all TYPE material was forwarded to Perth and secondly, that all PRH vouchers not duplicated in Perth were forwarded to Perth. Material remaining after this process was then assessed for incorporation into the Pilbara public reference collection. Material not required for these purposes was, in priority order, offered to Rio Tinto Iron Ore for their Dampier-Hamersley reference collection; forwarded to the

Australian National Herbarium (CANB); and/or forwarded to Perth for use in the Perth (State) public reference collection or for distribution to other Australian herbaria.

Summary of progress and main findings

- All PRH TYPE vouchers forwarded to Perth.
- All PRH vouchers not duplicated in Perth forwarded to Perth.
- Numerous vouchers retained for incorporation into a Pilbara public reference collection.
- Numerous vouchers offered to Rio Tinto Iron Ore for reference herbarium purposes.
- Pilbara Regional Herbarium closed.

Management implications

The necessity to close the PRH and the actions implemented to ensure that the collection of ~12 000 vouchers is appropriately valued (conservative replacement value of approximately *$550,*000) and preserved was successfully achieved.

The closure of the PRH somewhat restricts the ability of the Pilbara community to confirm the identity of native plant species however the return of a comprehensive public reference collection will go a long way to moderating this issue.

Future directions (next 12-18 months)

- Reinstate Pilbara public reference collection in Karratha.

DEC Regions

Pilbara*.*

IBRA Regions

Pilbara*.*

NRM Regions

Rangelands*.*

Kimberley Nature Conservation output liaison, including submissions to acquire funding support for Kimberley islands biodiversity survey

Core Function - Policy

Team members

A Start (0.05), N McKenzie (0.05), S van Leeuwen (0.05), AA Burbidge (External); Total (0.15).

Context

The North Kimberley bioregion is rich in biodiversity, but poorly known compared with some other bioregions. Access to and understanding of Kimberley biota, and threatening processes including altered fire regimes, weeds, grazing by feral animals, and impacts of other invasive pest animals, is required for developing sound conservation management strategies and actions.

Aim

To liaise with and advise the Kimberley Regional Manager on nature conservation output, support nature conservation staff over technical issues and liaise with Kimberley Land Council (KLC) on access and collaboration. To prepare the concept plan for the Kimberley islands biological survey and secure funding for this survey

Summary of progress and main findings

- Funding for Kimberley islands biological survey obtained from NHT Strategic Reserve Fund for 2 years and through DEC for third year.

- Ongoing liaison on nature conservation output (Regional Manager), technical support (regional staff) and with KLC re collaboration during the island survey in respect of 6 of the 19 islands to be surveyed.
- Science Project Proposal (SPP) submitted and approved (2007/0001) for Kimberley islands survey.

Management implications

- Protection and management of the island's biodiversity values.

Future directions (next 12-18 months)

- Ongoing liaison and advice as requested.
- See Kimberley islands survey SPP ((2007/0001) for further details.

DEC Region
Kimberley.

IBRA Regions
North Kimberley, Central Kimberley, Victoria Bonaparte, Ord Victoria Plains, Dampierland.

NRM Region
Rangelands.

FAUNA CONSERVATION

Program Leader: Keith Morris

Development of effective broadscale aerial baiting strategies for the control of feral cats

SPP # 2003/0005

Team members

D Algar (0.4), J Angus (0.5), M Onus (0.5); Total (1.4).

Context

Control of feral cats is recognized as one of the most important fauna conservation issues in Australia today. The impact of feral cats on native fauna is acknowledged by Commonwealth legislation, as outlined in Schedule 3 of the Environment Protection and Biodiversity Conservation Act 1999. The national 'Threat Abatement Plan for Predation by Feral Cats' (TAP) lists 38 species on Schedule 1 of the above Act for which there is a known or inferred threat from feral cat populations. Development of an effective broadscale baiting technique, and the incorporation of a suitable toxin for feral cats, was cited as a high priority in the TAP as it was most likely to yield an operational and cost-effective method to control feral cat numbers in strategic areas. The objective of this research program is to develop an effective and cost-efficient broadscale baiting strategy for feral cat control.

It aligns with Corporate Priority 3, KRA 2, sub-output NC 2A, KRA 4, sub-output NC 4A and 4B. The research is also relevant to and consistent with recommendations 1, 2, 8-11 made by the 'Independent Review of Western Shield' panel report (February 2003).

Aims

DEC researchers have designed and developed a bait medium that is readily consumed by feral cats. The program in progress, is aimed at developing optimal broadscale control programs for feral cats. A number of key factors are being researched to provide an effective broadscale 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 (completed).
- To examine baiting intensity (number of baits laid/km2) in relation to baiting efficiency to optimise control (ongoing).
- To examine baiting frequency required to provide long-term sustained effective control (in progress).
- 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. This risk assessment is in part required to gain Australian Pesticides and Veterinary Medicines Authority (APVMA) registration of the new bait as well as assuring the protection of native fauna.
- To provide a technique for the reliable estimation of relative cat abundance.

Summary of progress and main findings

Optimizing baiting programs

- Current research to optimise baiting programs is primarily being conducted at Lorna Glen, north east of Wiluna. The first experimental feral cat baiting program, conducted at this site, in 2003 was very successful. This baiting program follows similarly successful campaigns at other arid zone sites e.g. Gibson Desert Nature Reserve and Wanjarri Nature Reserve. As part of this adaptive management program, ongoing feral cat baiting campaigns are being conducted to

develop and prove baiting strategies to provide long-term sustained and effective feral cat control. The programs are designed to provide replication of the previous studies listed, to enable determination of the confidence limits to which baiting outcomes in the arid zone can be predicted and to assess the rate and extent of reinvasion by cats over time. Further baiting programs have been conducted in 2004,2005 and 2006 with similar outcomes.

- 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. Detailed measurement of the extent, rate and timing of dispersal into a baited area is continuing.

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.
- 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 DSE (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. DEC researchers have focused attention on developing the technology to enable automatic insertion of spherical capsules into the baits during bait manufacture. This was accomplished in 2003-04 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 commenced in 2004 and has shown that encapsulation of the toxin would dramatically reduce the risk of exposure of the toxin to non-target species. This research is continuing.

Development of a technique to survey feral cat populations

- 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 ability of this technique and other options 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 directions (next 12-18 months)

- 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. It is expected that bait registration will commence at the end of 2007.
- Further development of techniques to efficiently and reliably survey feral cat populations.

DEC Regions

Research into optimizing 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 DEC Regions.

IBRA Regions

Research into optimizing baiting strategies is being conducted principally in the Murchison, Carnarvon and Gascoyne regions. Assessment of the potential bait risk to non-target species is of necessity being undertaken opportunistically across IBRA Regions.

NRM Region

Rangelands.

Sustained introduced predator control in the rangelands

SPP # 2007/004

Team members

D Algar (0.5), J Angus (0.5), M Onus (0.5), N Hamilton (1.0); Total (2.5).

Context

The objective of this project is to develop operational-scale introduced predator control techniques for the semi-arid bioregions in the lower rangelands. The program will build on the successful research programs and operational trials conducted in the interior arid zone at the Gibson Desert Nature Reserve and more recently at Lorna Glen. This is a collaborative project involving DEC and AWC. The research is being undertaken at AWC's Mt Gibson Sanctuary and at the nearby DEC acquired pastoral leases of Karara/Lochada. Mt Gibson Sanctuary is the treatment (baited) site and Karara/Lochada is the control or non-baited site, some 50 km distant. Feral cat bait and baiting methodologies (i.e. timing of baiting, baiting intensity and frequency) are being employed to assess an integrated introduced predator (feral cat, fox and wild dog) control strategy. This strategy involves an annual baiting program, conducted in winter, with baits distributed at a density of 50 baits km^{-2}.

The project will provide for the successful reconstruction and conservation of biodiversity as part of future expansion of 'Western Shield' into this region as when long-term, sustained control of introduced predators has been demonstrated, DEC will be in a position to carry out fauna translocations.

It aligns with Corporate Priority 3, KRA 2, sub-output NC 2A, 2B, KRA 3 sub-output NC 3H, KRA 4, sub-output NC 4A and 4B.

Aims

- Feral cats do not readily consume baits used in canid baiting programs, whereas feral cat baits provide an efficient mechanism for controlling canids. Baits to be used in this project and earlier baiting campaigns in the arid zone have been developed and produced by DEC, specifically for the control of feral cats. It is proposed initially to employ a feral cat baiting strategy and assess its impact on the abundance of feral cats and foxes. This strategy will involve an annual baiting program to be conducted in July/August with baits to be distributed at a density of 50 baits km-2. Monitoring the rate of reinvasion and distribution will dictate the necessity for and type of additional control programs for individual species through the year.

Summary of progress and main findings

- Pre-baiting surveys of introduced predator activity indicated a relative low level of fox abundance at Mt Gibson, possibly due to previous baiting history by AWC, but a high occurrence of cats. Both predators were relatively abundant at Karara/Lochada. A broadscale aerial baiting program was conducted at Mt Gibson Wildlife Sanctuary in July with the pre- and post-baiting surveys used to establish baiting efficacy. The comparison of introduced predator activity measured pre- and post-baiting indicated a highly effective campaign with no counts being recorded following

baiting.

- Introduced predator activity has been measured at approximately 3 monthly intervals (October, December, April) to provide information on the rate and extent of reinvasion into the baited site. Monitoring the rate of reinvasion and distribution will indicate the effectiveness of this strategy or dictate the necessity for and type of additional control programs for individual species through the year. These surveys have shown limited reinvasion onto the Mt Gibson site 6 months post-baiting. Foxes have dispersed into the area during the late summer/early autumn; however cat numbers have remained very low.
- Trapping grids and monitoring locations were established at both sites to monitor the prey resource. Two surveys are conducted; the first is conducted immediately prior to baiting (June) when prey availability is at its lowest and the second is conducted in spring or autumn (cyclonic rains) to assess the optimum prey resource. Surveys are being conducted to assess species presence and provide an index of relative abundance for mammals and reptiles, birds and invertebrates.

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 Rangelands.

Future directions (next 12-18 months)

- The next aerial baiting will occur in winter 2007, with pre-and post-baiting predator surveys and ongoing quarterly monitoring of predator abundance. Prey resource surveys will again be conducted in winter and spring.

DEC Regions

Research is being conducted in the Midwest Region.

IBRA Regions

Avon Wheatbelt and Yalgoo.

NRM Region

Rangelands.

Conservation of south coast threatened birds

SPP # not yet allocated

Team members

AH Burbidge (0.15), M Barth (1.0), with input from South Coast Region staff; Total (1.15).

Context

Identifying the conservation requirements of threatened south coast birds such as the critically endangered Western ground parrot, and vulnerable Western bristlebird and western subspecies of the Western whip bird will aid *in situ* management of these taxa. Understanding of responses to fire, biological and behavioral characteristics such as vulnerability to predation and nesting site requirements are essential knowledge for the conservation of these WA endemics. A high community involvement is maintained with over 40 volunteers per survey season. Community education and information assimilation is achieved through local and internationally focused media.

It aligns with Corporate Priority KRA 6 and KRA 4 sub-output NC 4C.

Aims

- To develop an understanding of the biological and ecological factors that limit the distribution and numbers of Ground parrots and Western bristlebirds, including habitat requirements, response to fire and predation pressure.

- To create management prescriptions that will increase the survival chances of the Ground parrot, Western bristlebird and Western whipbird and increase their total population size.

Summary of progress and main findings

- Obtained significant NHT funding.
- Existing long-term Ground Parrot monitoring data from one site in Fitzgerald River National Park analyzed and scientific paper in press.
- Vegetation change measured in long-term monitoring plots in Ground Parrot habitat in Fitzgerald River National Park, following wildfire that burnt some of the plots.
- Ground Parrot surveys continued in Fitzgerald River National Park; one major population apparently in decline.
- Monitoring in Drummond Track area continued; no nests found, but breeding confirmed by presence of fledglings.
- Results of Ground Parrot surveys in the Cape Arid and Fitzgerald River areas made accessible to all park managers and are being used for planning of fire protection and targeted predator control.
- Systematic survey for Ground parrots commenced in the Stirling Ranges area and in D'Entrecasteaux National Park.
- Further monitoring surveys for Ground parrots carried out in Waychinicup; results confirm that population numbers have dropped catastrophically in this area, but reasons are unknown.
- Further Nuytsland Nature Reserve surveys conducted by Friends of the Western Ground Parrot (Birds Australia WA) with planning, logistic and technical support from DEC.
- Proposal developed for study of impacts of cats on Ground Parrots in Fitzgerald River National Park.
- Proposal developed for bristlebirds to be translocated to Walpole-Narnalup and D'Entrecasteaux national Parks, near Walpole.
- Bristlebird population monitored in Fitzgerald Track area in relation to previous fire and other disturbance.
- Numerous media releases and presentations to community groups, general public and schools.
- High involvement of community in a dedicated volunteer program.

Management implications

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

Future directions (next 12-18 months)

- Analyse data from monitoring programs.
- Analyse and publish existing data on response to fire.
- Analyse existing video footage of Ground Parrots to determine nature of food items.
- Trial radio-tracking of Ground Parrots to improve knowledge of breeding biology.
- Investigate specific components of Western ground parrot and Western bristlebird biology that are essential to their conservation; including response to different fire regimes, habitat preferences, timing and location of breeding, juvenile dispersal, vocalization and population demographics.
- Implement feral cat control (with monitoring) in key ground parrot habitat.
- Implement Recovery Plans where funds permit (including monitoring and a trial translocation).

DEC Regions

South Coast, Warren.

IBRA Regions

Esperance Plains, Jarrah Forest, Warren.

NRM Regions
South Coast, South West.

Translocation outcomes and monitoring of naturally occurring populations of the western ringtail possum *Pseudocheirus occidentalis*

SPP # 2006/006

Team members

P de Tores (0.20), J Jackson (0.05), W Manson (0.05), J Dunlop (0.05); PhD Students - J Clarke, H McCutcheon, G Bryant; Murdoch University - K Warren, I Robertson, T Fleming.

Context

The ability to control introduced predators at a landscape scale is central to effective conservation management and to the success of DEC's Western Shield program. DEC has been instrumental in demonstrating the conservation value of introduced predator control programs and translocation programs. However, the long-term success of Western Shield will be judged not only by the Department's ability to control foxes and cats at a landscape scale, but also by the outcome of the suite of translocation programs, often undertaken at a more localized scale. It is also critical to demonstrate these translocations can result in a long-term sustained fauna recovery for a suite of threatened species. To date, the outcome of many localized translocation programs has been varied. Possible causes for the lack of translocation success has been attributed to a suite of factors including drought, mesopredator release, prey switching, unsuitable habitat at release sites, anthropogenic disturbances (including fire and fire management practices), disease (including pre existing disease/poor health of released founding stock) and competition with sympatric native species (de Tores *et al.*, 2004).

The western ringtail possum translocation program commenced in 1991 and by 1998 appeared to have met the criteria for success (de Tores *et al.*, 1998; de Tores *et al.*, 2004). The primary translocation release site, Leschenault Peninsula Conservation Park, subsequently suffered a population collapse. Possible causes for the collapse at Leschenault include those listed above, with the additional confounding factor of changes made to the 1080 baiting regime. These changes may have resulted in an increase in fox abundance/presence. All other western ringtail possum translocation release sites are yet to meet the criteria for success.

Aim

To determine translocation success at Leschenault Peninsula Conservation Park and Yalgorup National Park.

Summary of progress and main findings

- The ARC Linkage funded and DEC/Murdoch PhD supported projects have all progressed.
- Leschenault Peninsula (which is baited for fox control) has been the site of highest mortality. Cat predation has been implicated in the majority of cases (11 out of 15 predation events in 2006/2007). Carpet pythons are the second most common cause of mortality at this site (3 deaths in 2006/2007).
- All translocated ringtail possums have been health-screened prior to release, and again each time they are recaptured for collar renewal. To date all animals tested have been negative for toxoplasmosis, leptospirosis, and salmonella. Chlamydia and cryptococcus results are pending. No unexpected hematological or biochemical findings have eventuated.
- At sites of naturally occurring populations, 8 western ringtail possum deaths have been recorded. Fox predation/scavenging has been implicated for three of these deaths (two at the baited site at Ludlow and one at the unbaited site at Gelorup), with predation by raptors suspected for the remaining five deaths (all at the baited Ludlow site).
- Twenty one pythons have been implanted with radio transmitters since May 2006 (inclusive of pythons in the DEC / IA CRC northern jarrah forest mesopredator release study). These have been monitored weekly for observational and location data. Thermal biology data is being collected regularly from each python, through both the temperature sensitive radio transmitters

and implanted temperature data loggers. Dietary analyses will commence in July 2007.

- Field work for the Murdoch Honours project examining the availability of alternative sources of prey (alternative prey to the western ringtail possum) is complete.

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, DEC has no mechanism to deal with displaced or rehabilitated western ringtail possums.
- Translocation of the western ringtail possum has largely been driven by the need to relocate possums displaced from development sites where habitat is destroyed and the resident possum populations displaced. There will be an ongoing requirement to clear land for housing and for industry in the Swan Coastal Plain and this will continue to result in habitat loss and displacement of resident populations of the western ringtail possum. There will be a continued need for translocation of these displaced possums and an additional requirement to release orphaned and injured possums which have been nurtured and/or rehabilitated by wildlife carers. However, with the current high rate of loss to predation from cats, continued translocation of western ringtail possums displaced from development sites and ringtail possums ex wildlife carers can no longer proceed without an expectation of criticism from wildlife carers and the community in general. There will be an expectation that DEC address the issue of increases in the number of cat predation events at translocation sites where fox baiting occurs.

Future directions (next 12-18 months)

- The three PhD programs will continue to assess survivorship of translocated individuals and the importance of predation, competition and disease at the translocation release sites (Judy Clarke), at sites of naturally occurring populations (Helen McCutcheon) and the importance of predation by the south-west carpet python to translocation outcomes (Gillian Bryant).
- Research will also focus on assessing fox and cat density at the Leschenault translocation release site and, subject to availability of a DEC's bait for cat control and trials on non-target species, cat control will be implemented at Leschenault Peninsula Conservation Park.
- Trapping will also continue to assess the availability of alternative prey (alternatives to the western ringtail possum as a prey species) at the Leschenault translocation release sites.
- A Murdoch / DEC Honours project will commence to assess nest box preference by western ringtail possums held in care and use of nest boxes post release at translocation sites.

DEC Regions
Swan, South West.

IBRA Region
Swan Coastal Plain.

NRM Region
South West.

The importance of fox, cat and native predator interactions to sustained fauna recovery in the northern jarrah forest – is there a mesopredator release effect?

SPP # 2006/005 (One of 4 projects carried out as part of the DEC and Invasive Animals Cooperative Research Centre (IA CRC) Western Australian Demonstration Site)

Team members

P de Tores (0.75); IA CRC / DEC funded technical support - J Jackson (0.95), W Manson (0.95), J Dunlop (0.95);

IA CRC funded post doctoral research scientists – A Glen (chuditch) (1.0) and D Sutherland (varanids) (1.0).

Two PhD students - G Bryant – pythons (undertaken in this project and in conjunction with the

western ringtail possum translocation sites) and J Cruz (brushtail possums).

Two international exchange students (USA Bureau of Land Management): C Shephard (July to Aug 2006), S Garretson (June 2007).

Context

Fauna recovery within Western Australia is largely dependent upon the effectiveness of localized and large scale introduced predator control programs. DEC has been instrumental in demonstrating the conservation value of such programs. It is largely as a result of DEC's pioneering research and ability to demonstrate a response to fox control that the removal or mitigation of invasive species' impacts is now seen by other land management and conservation agencies as an essential component for the recovery of many species. However, recent research has demonstrated fauna abundance, distribution and recovery is highly unlikely to be a function of a single dimensional causal factor such as predation (de Tores *et al.*, 2004). Consistent with this hypothesis, some of DEC's Western Shield projects have not been able to demonstrate a response to fox control. In most of these cases there is insufficient information to determine why some programs have been unable to demonstrate a response to baiting programs or to unambiguously determine why translocation programs have been unable to demonstrate success.

In 2004, DEC agreed to participate in an application by the Pest Animal Control Cooperative Research Centre (PAC CRC) to the Commonwealth's CRC Program to develop a new Invasive Animals CRC (IA CRC). DEC has been a partner in the PAC CRC, and its predecessor (Vertebrate Pest Control CRC), since its inception in 1992. This partnership has provided substantial support to enable DEC to carry out research into fox and feral cat control measures, and impacts of introduced predators on native fauna.

The IA CRC application was successful and the new centre is supporting a 'Demonstration Ste' in Western Australia. The northern jarrah forest research is one of four components in the WA Demonstration Site.

Aims

- The mesopredator release hypothesis will be tested at the landscape and local scale.
- The importance of other factors to fauna recovery and translocation success will also be assessed, namely the importance of:
    - site specific habitat factors (e.g. floristics, vegetation structure, vegetation structural complexity / mosaic complexity).
    - prey switching and alternative prey availability.

Summary of progress and main findings

- The northern jarrah forest aerial baiting regime has been established and ground baiting has now also been established to coincide with the aerial delivery of 1080 baits.
- Captive animal trials to determine the most appropriate technique for collection of fox and cat hair have shown hair can be collected for subsequent molecular analysis/genotyping. Hair has been collected from foxes and cats from a single collection device.
- Collaboration with Oliver Berry (IA CRC / UWA) has shown genotyping is possible (foxes) from 1 individual hair.
- The first satellite collar (fitted to a feral cat in the unbaited control) has now been deployed
- Estimates of population density for the chuditch have been calculated from mark-recapture data for two areas, and these show that large numbers of chuditch are present in some parts of the northern jarrah forest.
- Two chuditch are currently equipped with radio-collars, and a further ten will shortly be fitted with GPS data loggers to give detailed information on their movements. A successful pilot study has been completed to determine the suitability of spool-and-line tracking for sampling microhabitat use of chuditch.
- Field trials have been carried out to determine the most effective means of capturing varanids in the northern jarrah forest. Results suggested that both large species, *V. gouldii* and *V. rosenbergi* may best be trapped in wire cage traps baited with rotten meat and captured with a rod and

noose apparatus in association with road surveying.

- Techniques have been developed to surgically implant radio-transmitters and temperature data-loggers into varanids, four individuals have been tracked since March 2007.
- Spool-and-line devices have been successfully trialled to measure microhabitat use of varanids. The devices worked well and a simple quantitative measure has been developed to score structural density at a scale relevant to animals of this size.
- Customized GPS logger units designed for mounting on varanids have been ordered to be deployed in October 2007 when these reptiles emerge from their period of cool weather inactivity.
- Radio-telemetry trials have been completed for the contact/proximity telemetry for prey species, and although the technique does not meet the expectations envisaged from manufacturers' claims, the trials have shown contact events will be consistently recorded on prey species' data loggers when transmitters are within 5m of each other. Expectations were that the prey species data loggers would be able to log only those contact events within 2 meters or less. Deployment of contact collars on brushtail possums has commenced (J Cruz, PhD candidate), with a total of 12 possums fitted with proximity/contact radio-collars.

Management implications

- The proposal is based largely on findings from DEC's *Operation Foxglove* (northern jarrah forest). *Operation Foxglove* resulted in recommendations to increase the standard operational 1080 baiting regime from a frequency of four baitings per year to six baitings per year for large areas of the multiple use northern jarrah forest. The findings were based on a long-term study of survivorship of translocated populations of the brush-tailed bettong, or woylie, *Bettongia penicillata*. The study found the probability of woylie survivorship in areas baited six times per year was 10% higher than in areas baited at the standard operational baiting frequency of four times per year. Population modelling also showed translocated populations were unlikely to persist in the presence of the standard baiting regime. The project outcomes will provide managers with information on the effectiveness of increased levels of fox control
- The survivorship study (based on a sample size of 366 radio collared woylies, monitored continuously over a 33 month period) also indicated the number of radio-collared woylie mortality events attributed to predation by cats was greater in 2 of the 3 fox baited treatments than in the unbaited control. This pattern is consistent with the principle of mesopredator release. The project will examine if cats are increasing in abundance in the presence of fox control (mesopredator release) and will also determine if this leads to a net increase in the level of predation. The findings from the project will also provide managers with information on mesopredator release in relation to native predators' response in the presence of fox control – specifically it will determine if the chuditch and the 2 large species of predatory varanids (*Varanus gouldii* and *V. rosenbergi*) show a mesopredator release response.

Future directions (next 12-18 months)

- The project will enter the major data acquisition stage from July 2007. Emphasis will be on assessing fox and cat density through indirect means (sandplotting and genotyping form hair and scats), assessing use of the landscape by foxes and cats (satellite telemetry) and assessing the availability of prey species.
- Estimates of chuditch and varanids density will continue through trapping.
- Monitoring of the brushtail possums will continue.
- The outcomes will enable DEC to determine if, in the presence of fox control, cat predation limits or prevents a native fauna response. The outcomes will also enable DEC to determine if cat control techniques, specifically use of a cat bait, ameliorates this mesopredator effect.

DEC Regions
Swan, South West.

IBRA Region
Jarrah Forest.

NRM Regions
South West, Swan, Avon.

Factors affecting establishment in the numbat (*Myrmecobius fasciatus*) Recovery Plan

SPP # 1993/0145

Team members
T Friend (0.05), K Rusten (0.5); Total (0.55).

Context
The numbat is Western Australia's State mammal emblem and although currently categorized as Vulnerable, a 2005 IUCN review recommended that it be ranked Endangered due to recent declines of some populations. After a vigorous reintroduction campaign led by DEC, there are now 8 self-sustaining populations but less than 2000 animals in existence. Continued recovery relies partly on private conservation organizations and this project is now orientated towards handing over to Districts for monitoring populations on DEC-managed estate.

This project has received new funding from SCNRM under the Southern Prospects investment strategy through the 'Implementing recovery plans for South Coast Threatened Species' project, commencing in July 2005 and finishing in June 2008.

It aligns with Corporate Priorities 5, 8 and 12, KRA 4, KRA 6 and sub-outputs NC 4A and NC 4C for 2007/08.

Aims
- To measure the success of establishment of numbat populations through reintroduction.
- To attribute mortality to specific causes.
- To assess population abundance. If population growth is zero or negative, remove one of the factors causing mortality, and assess the effect of removing the cause of mortality on the growth of the population.

Summary of progress and main findings
- A new translocation of numbats, to Cocanarup Timber Reserve near Ravensthorpe, was carried out in December 2006, with financial support from South Coast NRM (technical officer salary) and the Western Shield Translocation Plan (operational costs). Three weeks before the translocation, a wildfire severely affected about half of the available habitat at the translocation site, but given that sufficient habitat remained unburnt, the translocation proceeded. Twelve subadult numbats bred at Perth Zoo and 2 adult males from Dryandra were released in December 2006 and monitored by aerial and ground-based radio-tracking. High mortality, mainly due to raptor predation, was recorded over the following months and by the end of June only one adult male survived (contact was lost with one other animal). It is likely that raptors from the adjacent burnt area were operating in the release area, increasing predation pressure at the time of release. With the recovery team's agreement, it is intended to release another group in December 2007, by which time it is believed that the raptor numbers at the release site will have decreased.
- A new sub-project, aimed at determining dispersal and rates and causes of mortality in juvenile numbats at Dryandra, was commenced in October 2006. While much data has been gathered in previous years on survival of adults, juveniles have not been collared due to the difficulties of growth – this problem has been solved by very close surveillance and frequent collar changes during the growth period. Ten juvenile numbats were radio-collared while still with their mothers and followed over the next 8 months. Dispersals of up to 8 km were recorded, but survival was poor, as no juveniles survived to the end of June 2007. Most predation was due to raptors, with one likely cat predation event. This project will be repeated in October 2007 using a larger sample size..
- Another project, to monitor movements in the early stages of independence, was carried out at

Dryandra in late October-November 2006. A family of 3 juvenile numbats and their mother were radio-tracked continuously for 2 weeks using 4 fixed stations and a team of 12 volunteers. Video monitoring at nest sites was also used to build up a picture of numbat activity, specifically mother-young interactions, at this time. This project has allowed the documentation of a stage of the numbats life cycle that was poorly known before. This study will be repeated in October 2007.

- A driven survey, to monitor numbers, was carried out in November 2006 at Dryandra Woodland, resulting in higher sighting rates than in the last 2 years, indicating that numbat population there has recovered to some extent. Other driven surveys (Montague Block at Dryandra, plus Boyagin and Tutanning) and diggings searches were not carried out this year but are scheduled for next year. Diggings searches at other translocation sites will also be carried out in 2007-08.
- The status of the most recent WA translocation prior to Cocanarup, at the Stirling Range NP (SRNP), has been monitored since the commencement of that translocation in 1998 by maintaining radio-collars on individuals. No numbats have been released at SRNP since December 2005 and none of the 5 numbats collared as at July 2006 are still transmitting. The only female with young attached was found dead, probably a roadkill, one collar was found damaged in a way that indicates raptor predation and the other 3 signals were lost. There are now no radio-collared numbats remaining. Future monitoring of the population will be carried out by diggings searches.
- A manuscript describing a five-year study to determine the effectiveness of 'predator training' of captive-bred individuals by comparing the survival of trained and untrained individuals after release at SRNP, was completed and will shortly be submitted for publication.
- The Numbat Recovery Plan is being revised and will be submitted in July 2007.

Management implications

- Further searches are required in the northern jarrah forest and at Karroun Hill NR before concluding that these reintroductions have failed.
- Numbats persist at all other translocation sites in WA, SA and NSW and management guidelines for all these areas will be developed with the responsible agencies.

Future directions (next 12-18 months)

- Monitoring of known numbat populations will be continued by involving District staff and handing over monitoring responsibility to Districts. Regular 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 workshop to instruct district staff in numbat diggings recognition will be held at Dryandra in October 2007, with the aim of increasing District involvement in monitoring.
- A proposed numbat reintroduction site in Donnelly District will be assessed for a future translocation.
- Another release of zoo-bred numbats will occur at Cocanarup in December 2007, given recovery team support.
- A survey for numbats and feral cats at Dragon Rocks is proposed in 2007/08, with Narrogin District involvement. A survey for numbats will also be carried out at Karroun Hill NR.
- A revised recovery plan for the numbat will be submitted for adoption by the State and Commonwealth in July 2007.

DEC Regions

Swan, Wheatbelt, Warren, South Coast.

IBRA Regions

Swan Coastal Plain, Warren, Jarrah Forest, Avon Wheatbelt, Mallee, Yalgoo.

NRM Regions

South West, Swan, Avon, South Coast.

An assessment of the effect of fox control on *Phascogale calura* (red-tailed phascogale) populations

SPP # 1993/0149

Team members

T Friend (0.05), L Bell (0.5); Total (0.55).

Context

The red-tailed phascogale is ranked Endangered on State, Commonwealth and IUCN threatened species lists, although a recent IUCN review recommended a reduction to Vulnerable. It is present in many small reserves and on private property in the Upper Great Southern and sporadically on the south coast and eastern wheatbelt and thus offers umbrella status as a threatened species for which landholders can provide habitat.

This project aligns with Corporate Priorities 5, 8 and 12, KRA 4, KRA 6 and sub-outputs NC 4A and NC 4C.

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.
- In 2005, fox control ceased on 2 reserves that had been baited since 1994, creating an opportunity to refine this investigation into the effect of baiting. Another monitoring round was carried out in April/May 2007. Results supported earlier conclusions that red-tailed phascogale numbers are not strongly influenced by fox control, although numbers were low at all sites, probably due the low rainfall in the previous year. Continuation of this program, at least until good rains are recorded, will provide a more robust answer to this question. Funding is being negotiated through Avon Wheatbelt NRM for this program.

Management implications

- At this stage there is little evidence that fox control is an important requirement for the persistence of remnant RTP populations, although recovery after dry seasons is more rapid under fox control. It is likely that movement between habitat patches and along corridors between reserves is inhibited by fox presence.

Future directions (next 12-18 months)

- Results of this project to date will be written up during 2007/08. However it would be valuable to establish an ongoing (e.g. 2 yrly) monitoring round and this is likely to receive some District support.
- Studies on red-tailed phascogales in the South Coast NRM region will commence in 2007-08 and will comprise distributional surveys using hair funnels, to be carried out in conjunction with dibbler distributional surveys, and habitat preference studies, to be carried out in the Fitzgerald River National Park.
- A recovery plan for the RTP is currently being completed involving community input and will be submitted in July 2007. The plan recommends the continuation of this study and the strong involvement of landholders and local community members.

DEC Region

Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Regions
South West, Avon.

Dibbler (*Parantechinus apicalis*) Recovery Plan
SPP # 1995/0011

Team members
T Friend (0.1), T Button (1.0), K Rusten (0.5); Total (1.6).

Context
The dibbler Recovery Plan 2003-2013 lays out a set of actions to improve the conservation status of this small marsupial, ranked Endangered in State, Commonwealth and IUCN threatened species lists.

This project aligns with Corporate Priorities 5, 8 and 12, KRA 4, KRA 6 and sub-outputs NC 4A and NC 4C.

Aim
- To implement the Dibbler Recovery Plan, and thereby improve the conservation status of the dibbler by:
- Protecting and monitoring existing populations.
- Increasing the number of known populations by searching for undiscovered populations and re-establishing dibblers in areas where they have become extinct.
- Documenting and explaining dibbler distribution in the Fitzgerald River NP.

Summary of progress and main findings
- Funding for the Dibbler Recovery Plan is currently available from 2 sources:
- The South Coast Threatened Species project includes some aspects of dibbler recovery, in particular the more research-orientated actions including a detailed survey of dibbler distribution in the FRNP.
- In addition, a Regional Competitive Component (cross-regional) project has been funded for 3 years (July 2005-June 2008), to cover translocations and monitoring in particular, in both the South Coast and Northern Agricultural regions. This project involves surveys for dibblers and suitable dibbler habitat on the west coast and if appropriate, a translocation. It also involves the monitoring of the Jurien Bay island populations.
- Monitoring of the 2 Western Shield transects in the Fitzgerald River NP (FRNP) showed that numbers were still high in 2006/07.
- Population numbers on Boullanger and Whitlock Islands are high and on Escape Island they have decreased since 2006, but not below acceptable levels as defined in the Recovery Plan.
- A new population study has continued at a newly discovered dibbler site with all-weather access in the eastern FRNP. This site allows comparative data against which to assess population parameters in reintroduced populations.
- The first mainland translocation of dibblers, to Peniup NR, was carried out in 3 releases, in 2001, 2002 and 2003. Fox control by aerial or ground baiting, was carried out between 8 and 12 times a year. In spring 2004, 52 individuals, including 45 juveniles, were captured, indicating that a self-sustaining dibbler population had been established. However, heavy rain in April 2005 and subsequent wet conditions over winter prevented ground baiting under dieback hygiene guidelines. Regular monitoring by trapping was carried out in October 2005 and although capture rates are usually high in spring as juveniles enter the population, only 3 adult males were captured. No captures were recorded in December. It was hypothesized that a high level of

predation followed fox invasion during the lapse of baiting. Consequently, District guidelines have been amended to allow baiting on foot should wet soil conditions prevent vehicle access and monthly baiting was reintroduced with rigorous guidelines to ensure its regularity. Subsequently, in spring 2006, the trapping program recorded 9 dibblers, including 8 new animals, indicating the survival of some adult females and successful reproduction. Another 6 captive-bred dibblers were released in Peniup soon afterwards and the population seems to be recovering. This finding underlines the importance of regular baiting, especially in small isolated remnants such as Peniup (6530 ha).

- Releases in October 2004 and October 2005 followed the approval of a translocation proposal to transfer captive-bred dibblers from the Perth Zoo breeding colony to a site in the Stirling Range NP, in a management cell adjacent to the southern boundary. Baiting was carried out by air 4 times a year, supplemented by ground baiting around the NP boundary at the same frequency. Monitoring by trapping showed that although a few dibblers survived the summer period, no dibblers apparently persisted in the area. A proposal to carry out monthly ground baiting around the dibbler release area was approved and the new baiting regime commenced before the next scheduled release of zoo-bred dibblers in October 2006. In February 2007, 2 new dibblers were captured in the monitoring grid on the release site. Hair arching in areas adjacent to the monitoring grid also detected the presence of dibblers.
- Student projects continue to be supported on the Jurien Bay islands, although there are no dibbler-focused projects at present. A Stewart has successfully completed her PhD study on dibbler-mouse-dunnart interactions on the Jurien Bay islands (Boullanger, Whitlock and Escape). This work indicates that competition between dibblers and mice is rare, and that mice would be more severely affected than dibblers. This is valuable information in the light of suggestions that mice should be removed at all costs. A workshop to decide on action to be taken regarding mice on Boullanger and Whitlock islands will be held in July 2008.
- Dibbler surveys in FRNP have focused on a hair-funnel resurvey of the Chapman and Newbey sites from the 1984-5 biological survey. Analysis of the presence-absence data generated will be carried out by Dr L Gibson using a digital elevation model.

Management implications

- Appropriate management for biodiversity depends on adequate knowledge of species distributions and habitat preferences, particularly threatened species.
- Results from both Peniup and SRNP indicate strongly that monthly ground baiting is necessary to maintain dibbler populations, at least in small isolated remnants and in large areas adjacent to farmland.
- The study of mouse-dibbler interactions may have implications for mouse eradication on Boullanger and Whitlock Islands.

Future directions (next 12-18 months)

- Monitoring of the Peniup and Stirling Range translocations and the FRNP and Jurien Bay island populations will continue.
- A site for a new translocation, preferably in DEC's Midwest Region, will be selected by the recovery team in consultation with Regional and District staff. This translocation will be funded in the first year by the cross-regional NHT project, but subsequent funding will need to be negotiated, possibly through the Western Shield Translocation Plan or NHT through the Northern Agricultural Catchment Council.
- The study of dibbler distribution in the FRNP will continue in 2007/08, incorporating an expedition into the Wilderness Area, jointly with western ground parrot and western bristlebird survey teams.
- Dibbler surveys will be continued eastwards in 2007/08, especially between Hopetoun and Esperance.
- The study of dibbler habitat preferences based on the distribution of captures on trapping grids will continue in 2007/08.

DEC Regions

Midwest, South Coast.

IBRA Regions
Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Esperance Plains.

NRM Regions
Northern Agricultural, South Coast.

Gilbert's potoroo (*Potorous gilbertii*) Recovery Plan

SPP # 1996/0008

Team members
T Friend (0.75), S Hill (1.0), V Hack (0.5), S Schreck (0.5); Total (2.75).

Context
Gilbert's potoroo is Australia's most endangered mammal. The Gilbert's Potoroo Recovery Plan 2003-2008 provides a list of actions to improve the conservation status of this Critically Endangered species. This project receives funding from the SCNRM investment plan under the South Coast Threatened Species Project and involves collaborative connections with Perth Zoo, universities, the Foundation for Australia's Most Endangered (FAME), private sponsors and the Albany-based Gilbert's Potoroo Action Group.

It aligns with Corporate Priorities 5, 8 and 12, KRA 4, KRA 6 and sub-outputs NC 4A and NC 4C for 200/08/07.

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
- The establishment of a new population of Gilbert's potoroos on Bald Island has occupied a large proportion of research and recovery effort in 2006/07. Seven animals have now been transferred from the Mount Gardner population via captivity to Bald Island, including 2 in August and one in December 2006. Six field trips were carried out during 2006-07. In September and February field trips, the first 2 independent young to be recorded on Bald Island were captured as new animals. During the most recent field trip, in June 2007, all 7 translocated animals were captured, showing that there has been no mortality amongst that group, and both (female) independent young, were also captured, both carrying pouch young. This project has been supported in 2006-07 by the BCI program and will receive further support in 2007-08.
- Fieldwork for a collaborative health study of wild and captive Potoroos with Murdoch Veterinary Masters student R Vaughan finished in 2006-07. This study focuses on several previously identified disease agents and overall health status assessed through hematology, blood biochemistry and bacteriology. Laboratory work and writing-up is in progress. The study has focused on the health effects of an infection of genital organs by a *Trepanosoma* species, related to organisms that cause syphilis in humans and foot rot in sheep. The significance of the infection to potoroos is not known, although it seems to cause inflammation around the prepuce in males. Reproduction by infected females, at least, does not seem to be affected, however.
- Cross-fostering shows promise for application to Gilbert's potoroo, particularly as they are so closely related to long-nosed potoroos, a species in which husbandry is not demanding. In 2006-07, a captive colony of long-nosed potoroos was established at a site over 20 km from Two Peoples Bay, thus avoiding any risk that the long-nosed potoroos might escape. The first 2 Gilbert's potoroos were transferred to long-nosed potoroo foster mothers in November 2006 and another in April 2007. One of the first two, as well as the third young to be transferred were reared successfully by their foster mother (the same female long-nosed potoroo). The pouch young that failed to survive was not such a good match with the long-nosed young it replaced as were the other two. The trial will continue for the rest of this year before an assessment of the usefulness of the technique.

- A fox and cat-proof fence has been built around 14 hectares of remnant bush within a bluegum plantation adjacent to Two Peoples Bay Nature Reserve, to provide alternative accommodation for a pair of captive animals currently being held in the captive colony at Two Peoples Bay. These animals will be provided with supplementary food if need be and monitored closely. The change in husbandry may produce reproduction in these animals, which are currently not breeding. The construction of the fence was funded by a grant from the Foundation for Australia's Most Endangered Species (Inc).
- Regular trapping of the Mount Gardner population, which occurs every 4 months, has taken on extra importance as it is vital that the impact of removing animals for Bald I is closely monitored. Numbers have continued to be stable, until the latest monitoring session, in June 2007, which recorded the highest number of animals (24) and new animals (7) in the history of the monitoring program. It appears that the removal of potoroos for translocation has had no negative impact.
- Another BCI-funded program, the construction of a fox- and cat-proof enclosure at Waychinicup National Park, has commenced, with the appointment of a Project Officer. The fence is due to be completed in summer 2007-08, with the introduction of potoroos to follow the removal of cats and foxes. This project is a collaborative effort of Science Division and Albany District personnel. Science Division staff (T. Friend and S. Hill) will be responsible for acquisition, release and monitoring of potoroos in the enclosure, and will collaborate with District staff in the fence planning and removal of introduced predators.
- Continued support of Gilbert's Potoroo Action Group's educational and fundraising activities.

Management implications

- Results of the Bald Island translocation so far indicate that a new population can be established there. If enough animals can be obtained to found a new population there, it could offer the security of a second population unaffected by introduced predators and lacking most native predators. 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 directions (next 12-18 months)

- Continue to monitor the Mount Gardner population.
- Support cat-trapping efforts at Two Peoples Bay, and initiate a study of predation by Carpet pythons.
- Continue to monitor the Bald Island translocation and transfer 3 more animals in 2007-08.
- Continue the new cross-fostering trial using the long-nosed potoroo colony near Albany.
- Continue to evaluate removal and hand-rearing of large pouch young from the wild as a means to obtain new, less stress-prone captive animals.
- Modify the captive diet based on truffle analysis.
- Monitor the introduction of a male and a female potoroo previously kept at the Two Peoples Bay facility into the 14 ha fenced enclosure in the eucalypt plantation.
- Evaluate further translocation sites, both on the mainland and on other islands. In particular, implement a new BCI-funded program in 2007-08 to search for a new translocation site west of Albany, using evaluation of vegetation structure, quokka occurrence and fungal diversity. Fungi will be assessed both by collection of fruiting bodies and by examination of fungal spore content of scats of bush rats, quendas and quokkas captured at surveyed sites.

DEC Region

South Coast, Warren.

IBRA Region

Jarrah Forest.

NRM Region

South Coast, South West

Genetics and ecology of the western barred bandicoot (*Perameles bougainville*)

SPP # 1993/0163

Team members

T Friend (0.05).

Context

Bernier and Dorre Islands are of extremely high conservation value because they have retained populations of several mammals that are extinct on the mainland. Recovery of those species relies on reintroductions but for successful outcomes it is vitally important to understand and manage genetic, ecological and disease characteristics that are consequent on the long isolation of island populations.

This project aligns with Corporate Priorities 5 and 12, KRA 4 and sub-outputs NC 4A and NC 4C for 2006/07.

Aims

- 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.
- To investigate the conservation ramifications of disease issues in western barred bandicoots and to support veterinary investigations into pathological conditions.

Summary of progress and main findings

- Collaboration with Murdoch University Vet School academics and 2 PhD students working on the western barred bandicoot wart-like virus disease on an ARC Linkage Grant.
- PhD student S Smith at Griffith University has carried out a study of the genetic variability of island populations and derived mainland populations of WBB including the Dryandra population that is descended from the cross-breeding experiment carried out at Kanyana. We have provided Mr Smith with a strategic collection of ear tissue samples for this study.

Management implications

- The results of these studies, particularly relating to disease and genetics, will be of great value in managing wild populations and translocations of western barred bandicoots and other mammals surviving on islands.

Future directions (next 12-18 months)

- The results of the cross-breeding experiment conducted at Kanyana Wildlife Rehabilitation Centre commencing in 1994 will be written up in 2007.
- A paper on home range activity and nest use by WBB on Dorre Island is close to completion due in will be submitted for publication during 2008.

DEC Region

Midwest.

IBRA Regions

Geraldton Sandplains, Carnarvon.

NRM Regions

Rangelands, Avon.

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

SPP # 2003/0001

Team members

B Johnson (0.30), K Morris (0.05), PhD student – D Cancilla; Total (0.35).

Context

In Western Australia, the heath mouse is known in recent times from only 2 areas, Lake Magenta NR and Fitzgerald River NP. It's range has contracted in the last 30-50 yrs. It is only one of 2 threatened rodent species in WA without either a draft or completed recovery plan. This study has been undertaken as a PhD project and will provide the information necessary to prepare a recovery plan for this species.

This project aligns with Nature Conservation Output KRA 4 (recovery of threatened species), specifically NC 4C.

Aims

- 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 provide sufficient information to allow the development of a recovery plan.
- To facilitate the involvement of post-graduate studies.

Summary of progress and main findings

- Field work completed in March 2006.
- PhD now being written.

Management implications

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

Future directions (next 12-18 months)

- Complete PhD.
- Liaise with Victorian DSE regarding the preparation of a recovery plan for the species.
- Ongoing monitoring of the Lake Magenta (East Rd) population as part of the mesopredator research project.

DEC Regions

Wheatbelt, South Coast.

IBRA Regions

Mallee, Esperance Plains.

NRM Regions

Avon, South Coast.

Rapid survey of quokka (*Setonix brachyurus*) in the southern forests

SPP # (Concept Plan to be submitted)

Team members

G Liddelow (0.1) and regional staff as required.

Context

Recent research on quokka populations in the northern jarrah forest has shown an alarming decline in quokka populations in this part of their range. A rapid survey of the distribution and relative abundance of quokka populations in the southern forests was undertaken to promote the protection and conservation of quokkas, and to guide decision-making with respect to fire management and timber harvesting.

Aims

- 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

- Surveys completed for southern forests, although some gaps in survey area need to be filled. Draft report of findings completed.
- Surveys in northern jarrah forest commenced.
- The commencement of a PhD study into the ecology and management of the quokka in southern forests.

Management implications

- Application of interim guidelines for fire management to protect and/or regenerate quokka habitat.

Future directions (next 12-18 months)

- Complete data analysis and write-up of southern forests survey.
- Complete field survey of northern forests.
- Analyse and publish findings.

DEC Regions

Warren, South West, Swan.

IBRA Regions

Jarrah Forest, Warren.

NRM Regions

South West, South Coast

Monitoring selected vertebrate communities in the Perup Nature Reserve

SPP # 1997/009

Team members

G Liddelow (0.1), B Ward (0.1); Total (0.2).

Context

Perup forest east of Manjimup contains a rich assemblage of medium-sized mammals that were once more widespread. Monitoring of mammals in the Perup forest commenced in the mid 1970s, and represents one of the longest ongoing forest mammal monitoring programs in Australia.

Monitoring provides information about mammal population fluctuations, and responses to management practices, including fox control and fire management.

This project also involves community groups, including school groups, teachers and DEC Bushrangers.

Aims

- To monitor woylie (*Bettongia penicilata*) and other selected ground and arboreal mammal species in the Perup Nature Reserve (PNR) in different post-fire stages, twice per year (spring and autumn).
- To monitor introduced predators (fox and feral cat) using sand pads over time to assess the effectiveness of Western Shield baiting in the PNR.
- To train DEC Bushrangers in mammal conservation and handling.

Summary of progress and main findings

- Populations of woylies have declined significantly in the Perup / upper Warren area.
- Capture rates for woylies have declined from 60-70% to < 10% in some populations. This is similar to what was observed at Dryandra woodland in 2001/02.
- The relative activity of foxes and feral cats as assessed by sand pads appears to be low.
- A more detailed study into the woylie decline commenced.

Management implications

- Necessary to understand the reasons for this relative rapid population decline so that remedial action can be implemented. There is a need to improve techniques for assessment of activity of introduced predators and this will have implications for broader Western Shield monitoring.

Future directions (next 12-18 months)

- Continue monitoring woylie populations.
- Complete the detailed research program to understand causes of declines as proposed (A Wayne).
- Prepare annual progress report and publication.

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

Assessing the distribution and status of the wambenger

SPP # 2003/11

Team members

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

Context

Recent genetic work has suggested that the brush-tailed phascogale (*Phascogale* sp. nov.) in Western Australia (the wambenger) is a distinct species when compared with eastern Australian and northern populations of *Phascogale tapoatafa*. There is also some evidence that wambenger populations have declined recently, although the cause of these declines remains unknown. Whilst

hypothetical 'natural' cyclical fluctuations may account for at least some of these declines it is also possible that management activities such as fox baiting, logging and/ or fire may also be causal factors. In this study the locality records of brush-tailed phascogales will be collated from museum and other sources and will be examined to determine if reporting frequency has declined recently and if so when.

It aligns with Corporate Priorities 3 and 12, and KRA 4 (sub-outputs NC 4A and 4C).

Aims

- To determine if significant recent changes in distribution of wambengers have occurred.
- To determine the potential risk to wambengers from operational fox baiting campaigns using 'Probaits'.
- To determine the current conservation status of *Phascogale* sp. nov. 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.
- Field studies investigating the impact of toxic baiting programs on a population of Phascogales completed.

Management implications

- Wambengers were found to be unaffected by the 3 mg 1080 Probaits in the field Operational use of this bait type in all Western shield operations can now proceed.

Future directions (next 12-18 months)

- Revisit some localities to investigate if populations have recovered (dependent upon the availability of funding)
- Complete manuscript on bait development work and submit to journal for publication.

DEC Regions
Warren, South West.

IBRA Regions
Jarrah Forest, Warren.

NRM Region
South West.

Probait trials: phase 2

SPP # 2000/ 0014 (incorporates 99/ 0018)

Team members
N Marlow (0.35), A Williams (0.40); Total (0.75).

Context
A new Fox bait, 'Probait', has been developed that will decrease the cost of DEC's operational baiting campaigns significantly. Previous experiments have shown that uptake of Probaits by Foxes was less than that of the currently used dried meat baits. This difference in uptake was concluded to occur due to the lesser palatability of Probaits. Flavour additives were incorporated into the baits and then field tested for their ability to increase palatability and uptake. Trials were also conducted to ensure the addition of flavour enhancers did not decrease bait longevity.

It aligns with Corporate Priorities 3 and 12, and KRA 4 (sub-outputs NC 4A and 4C).

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 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 complete. Uptake of 'improved' Probaits by foxes found to be equal to that of dried meat baits.
- Pen trials showing that foxes will actually consume Probait and die were completed.

Management implications

- The uptake of Probaits by Foxes was increased to equal that of the dried meat bait, and so Probaits can be used operationally in all Western Shield sites.

Future directions (next 12-18 months)

- Complete manuscript on bait development work and submit to journal for publication.

DEC Regions

Goldfields, Wheatbelt, Warren, South West.

IBRA Regions

Avon Wheatbelt, Jarrah Forest, Coolgardie, Warren.

NRM Regions

Avon, South West, Rangelands.

Sustained fauna recovery in a fragmented landscape (Dryandra Woodland and Tutanning Nature Reserve

SPP # 2006/007

Team members

N Marlow (0.35), A Williams (0.90), N Thomas (1.0), B Macmahon (1.0), J Lawson (0.1); Total (3.35).

Context

The factors responsible for decreased survival and recruitment of woylies (*Bettongia penicillata*) in wheatbelt reserves in Western Australia (i.e. Dryandra Woodland and Tutanning Nature Reserve) will be investigated. Survival (#KTBA) will be measured as a function of fox abundance, cat abundance, and several other variables. Woylies will be radio-collared and monitored intensively to directly identify factors responsible for their demise. These may include predation from pythons or raptors, habitat productivity limitations or ineffective fox control (1080 loading too low, unsustainable non-target bait uptake, or bait shy foxes).

It aligns with Corporate Plan priority 5 and KRA 4 (sub-outputs NC 4A and 4C).

Aims

- To test the mesopredator release hypothesis at the landscape and local scale.

- To determine the causes of woylie decline.
- To test the effectiveness of current baiting regimes and to identify if resident foxes are present.

Summary of progress and main findings

- Trapping of woylies is ongoing and over 100 individuals have been captured. 18 woylies in Dryandra Woodland and 14 in Tutanning Nature Reserve are currently radio collared and are being tracked on a daily basis. The results of autopsies have been inconclusive to date. More effort is being expended in using DNA technology to identify predators from saliva and tooth marks.
- Sandplots have been established in Tutanning (75 plots), Dryandra (129 plots) Highbury block (unbaited 31 plots) and Quinns block (unbaited 32 plots). These have been monitored repeatedly and concerns about the effectiveness of the baiting regime especially in Tutanning Nature Reserve have been raised.
- Bait uptake (DMBs) by foxes and non-target species has been investigated using remote cameras. Bait uptake by foxes is extremely low: bait uptake by brush tailed possums may be unsustainable. These trails will be repeated with non-toxic Probaits. If necessary the baiting intensity at Tutanning Nature Reserve will be increased 10 fold (from 5 to 50 baits per sq km- (providing the 1080 risk assessment is acceptable)).
- The effectiveness of the current baiting regime at controlling foxes will be tested when radio-collared individuals are exposed to toxic baiting campaigns (including the 50 baits per sq km in Tutanning Nature Reserve).

Management implications

- If the current baiting regime is found to be inadequate or ineffective changes to the bating program may need to be made.
- Woylies have been recommended for relisting on the threatened species list.

Future directions (next 12-18 months)

- Continue to trap and monitor woylies to identify causes of mortality.
- Continue monitoring fox and cat abundance in all sites.
- Continue investigations of baiting effectiveness.
- Monitor the diet of foxes, cats (if possible) and wedge tailed eagles (if possible).
- If necessary and if cat baits available implement a cat baiting program.

DEC Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Region
Avon, South West.

Implementation of the Recovery Plan for the chuditch, *Dasyurus geoffroii*

SPP # 1993/0053

Team members
K Morris (0.25), B Johnson (0.25); Total (0.50).

Context
The chuditch is currently listed as a threatened species under both the *Wildlife Conservation Act 1950* (Fauna that is rare or is likely to become extinct), and the Commonwealth *EPBC Act 1999* (Vulnerable). A Recovery Plan was prepared for this species in 1994 and many of the recovery

actions have been completed. Translocations have been undertaken to 5 sites and monitoring of chuditch at other sites has been undertaken as part of the Western Shield fauna recovery program. Translocations are considered to have been successful at 3 of the 5 sites, and chuditch abundance appears to have increased at 76% of the Western Shield monitoring sites. Anecdotal sightings also suggest that this species may now no longer meet the IUCN criteria for Vulnerable, and should be downlisted. However, a more detailed analysis of the distribution, abundance and population trend is required before this assessment is made.

This project aligns with Nature Conservation Output KRA 4 (conservation of threatened species), specifically nature conservation output priority NC 4C, the enhancement of the conservation of threatened species.

Aims

- To ensure that chuditch persist within its present range at existing or increased population densities.
- To increase population numbers through the establishment of at least one population outside the present distribution.
- To review the conservation status of the chuditch using IUCN criteria, and revise the recovery plan if necessary.

Summary of progress and main findings

- Ongoing monitoring at key recovery/translocation sites completed confirming that chuditch have established at Lake Magenta, Julimar and Kalbarri, but not at Cape Arid or Mt Lindsey.
- Survey at Ravensthorpe Range and Cocanarup reserve indicated good populations at these sites.
- Chuditch also trapped at Dunn Rock Nature Reserve for the first time.
- Intense wildfire at Julimar in January does not appear to have detrimentally impacted on chuditch population.
- Collation of Western Shield chuditch monitoring data completed and review of conservation status undertaken.
- ARC linkage grant with University of NSW on Quoll genetics continuing.

Management implications

- Review of conservation status recommended that the chuditch remain listed as Vulnerable.

Future directions (next 12-18 months)

- Continue monitoring at key sites – Kalbarri, Julimar, Lake Magenta and jarrah forest sites.
- Revise Chuditch Recovery Plan.
- Undertake chuditch feral cat bait uptake trials in northern jarrah forest.

DEC Regions

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

IBRA Regions

Jarrah Forest, Esperance Plains, Mallee, Avon Wheatbelt.

NRM Regions

South West, Swan, Avon, South Coast.

Management of overabundant marsupials – North Island tammar wallaby case study

SPP # not yet allocated

Team members

K Morris (0.05), B Johnson (0.05), N Thomas (0.05), P Orell (Wildlife Branch), A Desmond (Midwest Region), Dr C Herbert (Uni NSW ARC linkage); Total (0.15).

Context

Some native mammals have become overabundant and now require management to reduce population numbers. In particular those that are constrained artificially (e.g. behind fences) or on islands can have a detrimental impact on vegetation through over grazing. Tammar wallabies were introduced to North Island in the 1980s from East Wallabi Is (Abrolhos) and are now having an impact on native vegetation which is leading to increased rates of erosion.

This project aligns with Nature Conservation KRA 3 and 6.

Aims

- To determine the effectiveness of Suprelorin contraceptive treatment on individual tammar wallabies (including contraceptive duration, health and welfare of the animal).
- To compare the longevity of contraception at 2 different dosages, 4.7 mg and 9.6 mg.
- Determine the proportion of the (female) population that has to be treated.
- To determine the effectiveness of fertility control as a method to reduce the population size of tammar wallabies on North Island (using East Wallabi as a control Island).
- Do any reductions in population size result in an improvement in the vegetation on North Island?
- To determine the genetic diversity of the population, which should confirm that the animals were introduced onto the island from the neighbouring Wallabi Islands and there were low founder numbers.

Summary of progress and main findings

- Field trip undertaken in May 2007, report prepared.
- No additional females implanted with Suprelorin as a lethal cull is planned for July 2007.
- Population estimate 400-450.
- 83 Tammar wallabies removed to captive breeding facilities at UNSW and University of Melbourne.
- Vegetation assessment inside and outside enclosures on North Island continued (Mid west Region).

Management implications

- Lethal cull to be undertaken by Mid West staff needs to be planned and executed carefully.
- Restoration of over-grazed and over-browsed vegetation on North Island needs to be monitored.

Future direction (next 12-18 months)

- Sample Wallabi Island populations of tammar wallabies for genetic status.
- Input into program to cull on North Island.
- Ongoing vegetation monitoring.

DEC Region

Midwest.

IBRA Region

Geraldton Sandplains.

NRM Region

Northern Agricultural.

Monitoring of mammal populations on Barrow Island

SPP # 2000/0012

Team members

K Morris (0.05), Pilbara Regional staff plus AA Burbidge (Post Retirement Research Fellow); Total (0.05).

Context

Barrow Island is one of Australia's most important nature reserves, particularly for mammal conservation. Monitoring mammal populations was a requirement of the Interim management guidelines for Barrow Island. A large LNG development (Gorgon) is planned for the island.

It is relevant to the nature conservation output priorities relating to the management of the conservation reserve system (NC 2C) and the conservation of threatened species (NC 4C).

Aim

- To establish and implement a monitoring protocol for native and introduced mammals on Barrow Island. This information gathered will be used by DEC 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

- Additional trapping grid established near Barrow airport
- Limited mammal monitoring undertaken in Sept 2006.
- Ongoing input into Departmental comments on the Gorgon EIS / ERMP.
- Ongoing supervision of a PhD project examining the social structure and genetics of boodies on Barrow Island (and other sites).
- Taxonomic work on the threatened Barrow Island mouse *Pseudomys nanus ferculinus* completed as an Honours project – not different to the mainland taxa.

Management implications

- Provision of baseline information on mammal abundance, and presence / absence of introduced mammal species. Development of monitoring protocols for native mammals and detection of introduced species.

Future directions (next 12-18 months)

- Meetings between DEC and Chevron staff to determine future directions of monitoring program.
- Undertake full monitoring in September 2007.
- More detailed analysis and publication of mammal trapping and spotlighting data.

DEC Region

Pilbara.

IBRA Region

Pilbara.

NRM Region

Rangelands.

Factors affecting fauna recovery in the Wheatbelt - Lake Magenta and Dunn Rock Nature Reserves

SPP#: 2006/009

Team Members

K Morris 0.40, B Johnson 0.90, B Muir 0.25; External Collaborators - Prof A Thompson (Murdoch University Veterinary School); Volunteer(s): at least 0.5 FTE.

Context

This project is a component of the investigation into introduced predator control and sustained fauna recovery in WA. It comprises part of DEC's contribution to the Invasive Animals CRC mesopredator release study and commenced in January 2006.

This project will provide information that will allow DEC to address the issue of better management of feral animals (Corporate Priorities special emphasis 2006/07 #3), and contributes to maintaining and developing a strong research program based on both in-house capacity and enhanced partnership (Corporate Priorities special emphasis 2006/07 #12). It is also relevant to NC KRA2 (NC2B), KRA 4 (NC4A), and to the Wheatbelt's priority to continue the implementation of the Western Shield wildlife recovery program.

Background and Aim

The European red fox (*Vulpes vulpes*) arrived in the south-west of WA in the late 1920s and has been implicated in the decline of several species of medium-sized marsupials. Like all canids, foxes are highly susceptible to the toxin sodium monofluoroacetate, or 1080 while most native WA mammals are tolerant to this poison. In areas of Western Australia where foxes were controlled with regular 1080 poisoning, populations of rock-wallabies (*Petrogale lateralis*), numbat (*Myrmecobius fasciatus*), tammar wallaby (*Macropus eugenii*), woylie (*Bettongia penicillata*), brushtail possum (*Trichosurus vulpecula*), and chuditch increased significantly. In 1996, the Western Shield fauna recovery program commenced, with fox baiting occurring over approximately 3.5 million hectares of conservation estate. In a short space of time, this led to a significant increase in woylie, quenda (southern brown bandicoot *Isoodon obesulus*) and tammar wallaby populations, and in 1998 these species were removed from the State and Commonwealth threatened fauna lists.

However, by 2000/2001 Western Shield monitoring started to detect declines in populations of some medium-sized mammals, most notably woylies, which had attained extremely high abundances (up to 60% trap success). In a review of Western Shield in 2003, Orell (2005) identified several sites in the south-west of WA where fauna had not recovered, or had declines, despite ongoing fox control. Lake Magenta Nature Reserve was one of these sites. Chuditch were reintroduced to Lake Magenta in 1996 and woylies were translocated there in 1997. Following 12 months of fox control, populations of the quenda and brushtail possum were also discovered. Presumably they had persisted at Lake Magenta prior to fox control commencing, but at undetectable levels. Trap success rates for all species increased in the period 1996-2001. However, after this time, trap success rates for quenda and woylies declined to a point where they are no longer trapped, and chuditch and brushtail possums have persisted, but at reduced abundances.

This project is part of a larger program examining introduced predator control and sustained fauna recovery in the rangelands and south-west of WA. In particular this project will be examining whether there has been a mesopredator release effect after several years of fox control i.e. have other introduced / native predators increased in abundance and become a threatening process for fauna survival.

Aims

- To determine the causal factors responsible for the medium-sized mammal declines at Lake Magenta nature reserve.
- To identify the management required to ameliorate these declines.
- To develop adequate introduced and native mammal monitoring protocols that will enable future changes in population abundances to be quantified and explained.

Summary of progress and main findings

- Analysis of previous baiting history completed – large variation in baiting periods for both aerial and ground baiting, little coordination between ground and aerial baiting.
- Estimates of fox and feral cat activity derived from sand pads at Lake Magenta and Dunn Rock nature reserves. Cat activity is higher at Lake Magenta.
- Probait uptake trails completed – less bait uptake at Lake Magenta.
- Two trapping session were completed – chuditch and brushtail possums recorded at Dunn Rock for the first time.
- Trapping webs set up at Lake Magenta – possum survivorship study commenced.
- Chuditch, possum, red-tailed phascogales, heath mice and western mice sampled for parasites as part of an ARC collaboration with Murdoch University.
- Project reviewed by external reviewers in November 2006, and the IA CRC in April 2007.

Management implications

- This project will provide knowledge of the causal factors responsible for declines of medium-sized mammals at Lake Magenta nature reserve, leading to more effective management and species conservation. This will be achieved through:
- An assessment of the effectiveness of the current fox control program.
- Determining whether mesopredator release (i.e. increased cat abundance) occurs following fox control.
- Identifying periods of peak abundance of potential fox/cat prey items to assist in improving fox/cat baiting efficacy.
- If necessary, the development of a baiting regime to effectively control both foxes and feral cats, and the testing of the effectiveness of this through translocations of vulnerable species.
- An understanding as to the role disease may play in regulating wildlife populations in WA.

The benefits to DEC include having the information required to improve fauna recovery in the Wheatbelt, and to have available revised native and introduced fauna monitoring protocols which will allow future changes in populations to be adequately assessed and explained. This project is also part of DEC's contribution to the Invasive Animals CRC.

Future directions

- Continue trapping and sand pad monitoring program on Lake Magenta and Dunn Rock.
- Commence vegetation and flora assessment of trapping grids.
- Commence trials to examine the effectiveness of aerial fox baiting at Lake Magenta (uptake of baits located on tracks vs baits located in dense shrubland).

DEC Regions
Wheatbelt / Katanning work centre.

IBRA Region
Mallee.

NRM Region
Avon Catchment Council.

Ecology and conservation of threatened pythons in WA

SPP # 93/0159

Team members
D Pearson (0.1); regional staff in Denham - L Reinhold (0.05); Total (0.15).

Context

Four of WA's 11 taxa of pythons are listed as threatened or in need of special protection. This project has undertaken ecological studies of 3 species thus far (South-west carpet python, Pilbara olive python and woma python) to provide basic information on their habitat requirements, diet, reproduction, distribution and conservation status.

The project aligns with Corporate Priorities 1.4, 1.5, 3.1, 3.4, 3.5, 4.4, 4.7, and KRAs 4.1 and 6.1.

Aims

- To document the ecology, distribution and conservation status of threatened and listed pythons in WA.
- Identify conservation threats to pythons and make recommendations on the management of populations.
- Undertake telemetry study of woma pythons.
- Collect material for future genetic work to aid wildlife forensics.
- Publish and disseminate research data to aid python conservation.

Summary of progress and main findings

- Ongoing radio-tracking of 10 woma pythons at Shark Bay and the collection of road-kills for morphometric and merisitc analysis.
- Over 950 individually marked pythons now on Garden Island with large numbers of recaptures providing useful data on growth rates, ontogenetic dietary shifts and time to recruitment in the adult population.
- Collection of scale clips and liver samples for future genetics work on pythons.
- Assistance to other researchers working on reptile ecology.

Management implications

- Pythons are disproportionately represented on WA threatened fauna lists. This research will clarify the conservation status of several taxa, threats to python populations and the relevant aspects of their ecology to plan management to mitigate threats.

Future directions (next 12-18 months)

- Review the telemetry study of woma pythons at Shark Bay in conjunction with Denham staff.
- Write up Pilbara Olive Python research.
- Continue a long-term mark recapture study on carpet pythons on Garden Island to understand population dynamics within a python population.
- Undertake further searches in the Northern Wheatbelt for extant woma python populations using community groups and local media outlets.

DEC Regions

Swan, Midwest, Pilbara.

IBRA Regions

Swan Coastal Plain, Geraldton Sandplains, Avon Wheatbelt, Murchison, Pilbara.

NRM Regions

South West, Rangelands, Northern Agricultural.

Implementation of the Lancelin Island Skink Recovery Plan

SPP # 1999/0011

Team members
D Pearson (0.05), Jurien Bay staff – R Hartley (0.05); Total (0.1).

Context
The only wild population of the Lancelin Island skink is found on Lancelin Island. A translocated population was established on Favorite Island in Jurien Bay in 2002. This project continues the actions identified in the recovery plan (Pearson and Jones 2000) to improve the conservation status of the species.

It aligns with Corporate Priorities 1.4, 1.5, 3.1, 4.4; Nature Conservation output KRAs 4.1, 6.1 and 6.3.

Aims
- To implement the Lancelin Island skink (LIS) Recovery Plan (Pearson and Jones 2000), especially the establishment of a translocated population on Favorite Island.
- To revise the recovery plan in conjunction with the LIS recovery team to reflect research work over the last 5 yrs and plan future actions.

Summary of progress and main findings
- The translocation of captive-bred skinks to Favorite Island was monitored in December 2006.
- Lancelin Island skinks have persisted on Favorite Island and have successfully bred, but capture rates are very low making it difficult to assess the effectiveness of the translocation.

Management implications
- The Lancelin Island skink has a very small geographic range. The translocation to Favorite Island will reduce its vulnerability to a natural or anthropogenic disturbance that may threaten the Lancelin Island population, thus improving its conservation status. Continued vigilance to manage tourism, prevent fires and avoid the introduction of exotic animals to either island will be required.

Future directions (next 12-18 months)
- Continued monitoring of the Favorite Island population to assess the success of the translocation with increased trapping intensity.
- Periodic monitoring of the Lancelin Island population and a survey of adjacent mainland for other populations.
- Survey for closely related sibling skink species in the Rockingham area.

DEC Regions
Swan, Midwest.

IBRA Regions
Swan Coastal Plain.

NRM Regions
South West.

Improving rock-wallaby conservation and management
SPP # 2006/003

Team member
D Pearson (0.2).

Context
Five species of rock-wallabies occur in Western Australia, as well as a number of distinct subspecies

and chromosomal races. Many taxa are threatened, primarily by feral animal predation, but fire and introduced grazers also impact upon populations. This project seeks to improve management and monitoring of rock-wallaby populations.

It aligns with Corporate Priorities 1.3, 1.4, 3.1, 3.4, 3.5, 4.4, 4.5, 4.7; Nature Conservation output KRAs 3.11, 4.1 and 6.1.

Aims

- Prepare a recovery plan for the 5 species of rock-wallabies that occur in WA.
- Survey rock-wallaby populations in Cape Range and Kalbarri National Parks, Western Desert and islands of the Recherché Archipelago.
- Evaluate the most appropriate techniques for monitoring rock-wallaby populations.
- Provide advice and assistance to DEC staff and other organizations carrying out translocations.

Summary of progress and main findings

- Consultation for the recovery plan well underway and a draft recovery plan is near completion.
- Surveys conducted of Cape Range National Park (with Cape Conservation Group); investigation of sightings at Cape Range NP; surveys of Salisbury, Westall and Wilson Islands in the Recherché Archipelago (with South Coast regional staff) and Pearson Island in South Australia (with SA DEH staff).

Management implications

- DEC commits substantial resources to the management of rock-wallabies every year across many regions of the State. At present, these activities are not co-ordinated by a Recovery Team or Plan. The Recovery Plan will allow DEC to improve its management of populations and will identify those taxa/ populations that require management intervention.

Future directions (next 12-18 months)

- Completion of draft Recovery Plan and circulation for comment and amendment.
- Write-up of papers on Cape Range rock-wallaby survey, Pearson Island survey and Recherché Archipelago survey.
- Survey of ranges in the Little Sandy Desert for rock-wallabies.
- Collaborative survey with Ngaanyatjarra communities in the Central Ranges bio-region.

DEC Regions

All, except South-west.

IBRA Regions

All.

NRM Regions

All.

Impact of cane toads on biodiversity in the Kimberley

SPP # 2006/004

Team member

D Pearson (0.5).

Context

Cane toads are rapidly advancing towards Western Australia. Knowledge of their impacts on the fauna is fragmentary. Similarly, our knowledge of existing fauna assemblages in the Kimberley is limited. This project will document pre-toad small mammal, reptile, frog and land snail assemblages

in the East Kimberley and undertake cafeteria trials in conjunction with ARC-linkage grant partners to identify those species susceptible to impacts from cane toads.

It aligns with Corporate Priorities 1.5, 3.1, 3.3, 3.5, 4.4; Nature Conservation output KRA 1.1, 2.1, 4.1, 6.1, 6.6.

Aims

- To determine the vulnerability of a range of vertebrate and invertebrate taxa to cane toad eggs, tadpoles, metamorphs and adults.
- To study the impact of cane toads on native taxa in field situations.
- To document existing vertebrate and land snail assemblages in the East Kimberley prior to the invasion of cane toads.
- To collect cane toads for future morphometric and dietary study.
- To make recommendations for management actions to reduce the impact of cane toads on biodiversity.

Summary of progress and main findings

- Successful ARC-linkage proposal with the University of Sydney, Dept. of Environment and Water, and the Australian Reptile Park.
- Sampling trips in January, February and June 2007 collecting reptile, mammal and land snails for cafeteria trials.
- Trials for a range of reptile and land snail species conducted at Fogg Dam.
- Establishment of frog survey sites around Kununurra and their sampling in January 2007.
- Vertebrate trapping to document pre-toad assemblages in Mitchell River and Mirima National Parks, Parry Lagoon Nature Reserve and other sites near Kununurra.
- Collection of roadkill reptiles and mammals with assistance of DEC staff and public to document pre-toad diets of species around Kununurra.
- Support and assistance for other researchers working on cane toad impacts.

Management implications

- The project is using cafeteria trials to identify those taxa at risk and behavioural and evolutionary responses of native fauna to cane toads. Field studies and radio-telemetry will be employed to verify the validity of cafeteria trials.
- The identification of susceptible taxa and those that will persist in the face of the toad invasion will allow conservation funds to be directed to those taxa of highest priority.

Future directions (next 12-18 months)

- Resampling of frog survey sites at regular intervals during the 2007-8 wet season to determine a probability baseline of detecting presence-absence..
- Pre-cane toad vertebrate and land snail surveys at sites in the East Kimberley and adjoining Northern Territory.
- Implantation of transmitters in some species of snakes and involvement of Kununurra community in their radio-tracking.
- Ongoing collection of roadkill specimens in WA and NT and support for other researchers working on cane toad impacts.

DEC Region

Kimberley.

IBRA Regions

Northern Kimberley, Central Kimberley, Ord Victoria Plains, Victoria Bonaparte.

NRM Regions
Rangelands.

Conservation of marine turtles

SPP # 1993/0040

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

Context
All marine turtles found in WA waters are listed as threatened species by the Commonwealth and the State.

This project aligns with Nature Conservation Output KRA 4, recovery of threatened species, particularly NC 4E, complete and implement the proposed State sea turtle and pinniped management plans.

Aims
- To gain an adequate understanding of the distribution and abundance of marine turtle populations utilizing WA rookeries and marine habitats, the nature of inter-relationships within species at the regional level between groups using different rookeries, and the linkages between nesting and living areas of importance for the maintenance of these adult turtle populations.
- To develop an understanding of the processes affecting maintenance and abundance of these marine turtle populations as an aid to addressing management needs.

To develop appropriate management measures and interpretation packages.

Summary of progress and main findings
- Most turtle management activities have been taken over by the Pilbara Region.
- Integrated tagging database developed.
- Ongoing liaison with State and Commonwealth agencies regarding management of threats to marine turtles.
- Continued input into Departmental response to the Gorgon EIS/ERMP in relation to flatback turtles on the east coast of Barrow Island.
- Ongoing study into monitoring of nesting beach temperature profiles.

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

Future directions (next 12-18 months)
- Liaise with Pilbara Region over the finalization of the WA marine turtle management plan.
- 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.
- Promote the use of the integrated turtle database – linking tagging, mortality and recruitment factors, and enlist expertise to undertake population modelling.
- Continue a study into the temperature profiles of nesting beaches along the north west coast and prepare report.

DEC Regions
Midwest, Pilbara, Kimberley.

IBRA Regions
Geraldton Sandplains, Carnarvon, Pilbara, Dampierland, North Kimberley.

NRM Regions
Rangelands, Northern Agricultural, Swan, South West.

Return to Dryandra
SPP # 2003/0002

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

Context
Developing cost effective captive breeding techniques and an understanding of effective reintroduction methodologies that can be implemented at an operational regional level is a priority of the Western Shield program. In 1998 the Return to Dryandra project was established to investigate the best methodology to captively breed and maintain 5 locally extinct wheatbelt mammalian species within large enclosures (two 10ha) at Dryandra, to investigate a range of reintroduction techniques and to provide animals for reintroduction to Western Shield fauna reconstruction sites where fox control is in place at a regional level.

The RTD project aligns with Corporate Priority 12, KRA 4 (sub-outputs NC 4A and 4C).

Aims
- 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
- Dalgytes and Boodies breeding very well and more releases are needed in the near future to reduce overcrowding in the enclosures. A release of Dalgytes to Lorna Glen is in progress and a soft release of Boodies into Dryandra Woodland is underway
- Field trial of a new folding soft trap for Mala completed allowing an increased trapping effort from 3 to 4 nights.
- Increased monitoring of Mala indicates that numbers within the enclosure are again lower than previously indicated. Some efforts (radio-collaring, monitoring and health screening) have been expended to discover the cause of the decline to no avail.
- Sightings and capture of wild born Dalgytes within Dryandra Woodland proper indicate that they have established well, albeit in low numbers.
- Ongoing supervision of District management of the RTD data base required.
- The -identity of the ‘wart-like’ syndrome pathogen infecting Western barred bandicoots has been confirmed Further procurement of marl for RTD enclosures on hold until disease is investigated.
- Joint Murdoch University and DEC project to investigate WBB wart-like syndrome progressing well.

Management implications
- Current level of Fox control within Dryandra Woodland may not be adequate for successful Boodie reintroductions / establishment, implication for other species within the Woodland

unknown.

- Limited prospects for reintroduction of the marl to mainland reserves until the 'wart-like' syndrome is resolved.
- Captive breeding of Merrnine within large open plan pens limited due to predation from wedge-tail eagles.

Future directions (next 12-18 months)

- All future work dependent on funding.
- Development of improved trapping techniques and protocols required for monitoring Dalgytes outside RTD enclosures.
- During 2005/06 investigate whether Dalgytes are impacting on Marl recruitment within the enclosures by manipulating Dalgyte numbers through removal for reintroductions.
- Continue release of Boodies into Dryandra to investigate methods to ameliorate predation from Foxes and investigate methods to enhance burrow construction by released Boodies.
- Continue with translocation of Dalgytes to Lorna Glen.
- Pursue translocation of Dalgytes to Perup.

DEC Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Regions
South West, Avon.

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

Team members
A Start (0.8), N McKenzie (0.1); AA Burbidge (Post Retirement Research Fellow) and Kimberley Region staff; Total (0.9).

Context
CWR mammals comprise an important and high-profile component of the State's fauna. Substantial funding is allocated to their recovery and management in the south-west. In view of evidence for continuing decline in tropical Australia, this project seeks to determine the status of CWR mammals in the Kimberley.

It aligns with Corporate Priority 12, KRA 3 and 4 and sub-outputs NC 3K and 4C.

Aim
To determine whether there has been a change (decline) in status of CWR mammals of the north and central 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

- Two publications prepared. Preliminary analysis of results indicates that medium sized mammals have declined in this area and the decline is progressive. 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

- Improved knowledge of status of Kimberley mammals.
- Advice on management of fire regimes and other disturbers in the Kimberley including better reserve boundary management and neighbour liaison.
- There are also important implications for management of islands and cane toads.

Future directions (next 12-18 months)

- 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.
- As CWR mammal populations appear to have declined widely except in the wettest coastal areas of the North Kimberley bioregion, 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. Survey, reservation and management of islands are likely to be critical to conservation of mammals in the State's tropical savannas. Funding for Island surveys (under the Biogeography program) is being sought.

DEC Region

Kimberley.

IBRA Regions

North Kimberley, Central Kimberley. Dampierland.

NRM Region

Rangelands.

Ecology of the ngwayir (*Pseudocheirus occidentalis*) and koomal (*Trichosurus vulpecula hypoleucus*) in the jarrah forest

SPP # 02/0002

Team Members

A Wayne (0.2), C Ward (0.2), C Vellios (0.2); Total (0.6).

Context

Understanding the ecology of the possums in the jarrah forest is integral to their effective conservation and the development of ecologically sustainable forest management practices including timber harvesting, fire management and introduced predator control. This research began in 2001 in response to the findings from the Kingston Project (SPP # 1993/115 and # 1997/007) that identified these 2 species as potentially the most susceptible medium-sized mammals to jarrah forest timber-harvesting.

This study aligns with Corporate Priorities with special emphasis for 2005/06 including 3, 10 and 12, and aligns with Key Result Areas 2, 3, 4 and 6.

Aims

- 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, etc).
- 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 in the jarrah forest of the Upper Warren region.

Summary of progress

- All fieldwork associated with all components of this research program was completed in 2004.
- PhD thesis submitted and accepted - Wayne, A.F., 2005. The ecology of the koomal (*Trichosurus vulpecula hypoleucus*) and ngwayir (*Pseudocheirus occidentalis*) in the jarrah forests of south-western Australia. PhD thesis. Centre for Resource and Environmental Studies, The Australian National University, Canberra.
- 5 Scientific papers published.
- Two scientific papers submitted for publication in a scientific journal.

Management Implications

- The improved methods can be used to facilitate more efficient monitoring (e.g. Western Shield) and research on the koomal and ngwayir necessary to clarify their conservation status and management issues.
- Improve ecologically sustainable forest management practices including timber harvesting, fire management, and introduced predator control.
- Improve the conservation of the threatened ngwayir and the koomal. Provide information directly relevant to the development and implementation of the Recovery Plan for the ngwayir. Identify key habitat and appropriate management and protection requirements for species recovery and maintenance of long-term viable populations.

Future directions

- Complete analyses and publish the following:
- The home-ranges, movement and spatial patterns of habitat use by koomal and ngwayir.
- Nocturnal habitat selection by koomal and ngwayir to complement research into diurnal refuge selection.
- The distribution and abundance of ngwayir in the Upper Warren in relation to environmental factors (e.g. nutrients, climate, water, vegetation structure, floristics etc) at local and landscape scales.
- The distribution and abundance of koomal in the Upper Warren in relation to (a) anthropogenic factors and (b) environmental factors at local and landscape scales.

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West (SWCC).

Identifying the cause(s) of the recent declines of woylies in south-western Australia

SPP # not yet allocated

Team Members

A Wayne (0.7), C Ward (0.5), C Vellios (0.5), M Williams (0.10), J Rooney (0.05), G Liddelow (0.05), B Ward (0.05); Total (1.95).

Context

Monitoring revealed that woylies were declining in Perup similar to what had been previously observed at Dryandra in 2001. Follow-up investigations have subsequently found that woylies at Dryandra have declined by about 90% since 2001. The Perup and surrounding Upper Warren region populations have so far declined by 90%. Similarly, woylies at Batalling (a 1982 reintroduction site east of Collie) have declined by 70% since 2003. A number of other Western Shield monitoring sites

(Orell 2004), also indicate declines throughout south-western Australia, all of which remain at low to undetectable densities. The cause(s) for these declines remains unknown and the conservation status of the species is currently under review in light of these recent findings.

Aims

- To determine the causal factor(s) responsible for the recent woylie declines in the Upper Warren region of south-western Australia.
- To identify the management required to ameliorate these declines.
- To develop adequate mammal monitoring protocols that will enable future changes in population abundances to be quantified and explained.

Summary of progress

- Since late October 2005, when the first indications of a woylie decline in the Perup were recognized, some of the key responses have included.
- The survey of 12 key transects throughout the Upper Warren region in October-December 2005 by Science and Donnelly District personnel to substantiate and assess the extent and magnitude of the declines.
- The identification and collation of existing available woylie data onto electronic databases to investigate:
- The spatial and temporal patterns of the decline.
- A preliminary assessment of the potential changes in demographic attributes of the woylie populations associated with the declines.
- Associations between woylie declines and climate, attributes of the fox baiting history and attributes of fire history.
- The convening of a Workshop (16 February 2006) attended by 32 relevant Science and Nature Conservation DEC personnel to:
- Provide an overview and understanding of the recent mammal declines in the south-west.
- Examine the potential cause(s) of these recent declines and associated evidence.
- Identify the priorities and strategies for a response to the recent declines.
- Establishment of a woylie Conservation Steering Group to co-ordinate and facilitate response activities including the development of a report and project proposal to Corporate Executive.
- The re-surveying of 11 key transects throughout the Upper Warren region in March-April 2006 to monitor the declines. More detailed and standardized data collection protocols were established and outlined in an Upper Warren Woylie Decline Monitoring Operations Handbook (Wayne *et al.* 2006) for this and future exercises. Results confirm that the declines are rapidly continuing with declines on some transects as great as 80% in the last 6 months.
- In collaboration with Murdoch University, extensive sampling of blood, faeces and ectoparasites during the March-April 2006 surveys are currently being analyzed to screen animal health, identify parasites and diseases present in the populations in order to identify possible agents of decline.
- The design and development of a formal research project to investigate the plausible causes for the recent woylie declines.

Management Implications

- The now substantial, rapid and extensive woylie decline throughout south-western Australia has a number of important biodiversity conservation and management implications including:
- The total abundance of woylies on DEC estate have returned to levels not seen for an estimated 20 years or more and constitute a nationally significant and major impact on this species. Without an appropriate management response the current trends bring to question the long-term viability of wild woylie populations in Western Australia.
- Woylies were delisted from State and Commonwealth threatened species lists in 1998. However, the conservation status of the woylie is currently being reviewed, with every expectation that it will qualify for an upgrade to at least the threatened 'Vulnerable' category based on IUCN criteria.

- Previously the flagship for earlier successes, the recent woylie declines no longer achieve DEC Corporate and Western Shield biodiversity conservation objectives for this species.
- The reasons for the declines remain unknown and no recoveries of impacted populations have yet been observed. It is therefore difficult to provide a reliable extinction risk assessment and detailed advice as to what the most effective conservation and management responses should be for their long-term sustainable persistence.
- Given the limited success of translocations and reintroductions in the wild, it is unlikely that this strategy will help mitigate current circumstances and may well exacerbate the problem. A moratorium on woylie translocations is strongly recommended until the risks can be better assessed.

Future directions

- Commence the proposed formal research program that includes;
- Meta-analysis of existing data.
- Ongoing monitoring of key transects at the regional scale.
- Intensive population comparison study with 5 specific sub-components:
- Density and demographics
- Survivorship and mortality
- Relative activity / abundance of predators
- Resource availability and accessibility
- Disease

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

Conservation of Western Australian butterflies

SPP # 1993/0022

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

Context
Invertebrates constitute a major part of the State's biodiversity. No biological survey can claim to be truly 'systematic' and no reserve system truly 'comprehensive', if invertebrates are overlooked. This project focuses on a high-profile group of terrestrial invertebrates (butterflies and day-flying moths) that are not sampled using traditional biological survey techniques. By involving community organizations, it extends co-operative partnerships with the community.

This project aligns with Corporate priorities 2, 6 and 8; KRA 1, 2, 3 and 4; and sub-outputs NC 1C, 2B, 3H, 4C, and 6A.

Aims

- To undertake strategic research to enhance our ecological knowledge of threatened butterfly and day-flying moth taxa, and identify management strategies to enable effective conservation. Develop survey techniques to accurately assess butterfly biodiversity and use these to assess the abundance and species richness of butterflies in remnant bushland areas. Determine what factors may be causing loss of butterfly diversity.

- To review the taxonomic status of those taxa where systematics is uncertain, using genetic methods to better delimit those taxa.

Summary of progress and main findings

- Submitted manuscript on methods of surveying for butterflies and day-flying moths in Western Australia to *Austral Ecology*.
- Completed further abundance and habitat surveys of a proposed critically endangered butterfly (the Arid bronze azure, *Ogyris subterrestris petrina*) in Goldfields region and established new transects at Barbalin Nature Reserve. Liaison with the local District and Vegetation Protection Branch enabled this new population to be protected from proposed road works.
- Published extensive records of butterflies from the inland and southern areas of WA, expanding knowledge of butterfly distributions.
- Published records of butterflies from Christmas Island, increasing our knowledge of the butterfly fauna of WA's off-shore islands, and incidental observations of butterflies on Mauritius.
- Published Landscope article on Middle Island.

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 directions (next 12-18 months)

- Complete paper for MEDECOS conference on third year of fieldwork.
- Publish paper on survey methods for butterflies and day-flying moths in Western Australia.
- Conduct further surveys of potentially endangered WA taxa, particularly *O. subterrestris petrina*.
- Apply for funding for work on the arid bronze azure, a proposed critically endangered butterfly, and for the graceful sun moth.

DEC Regions
Swan, Goldfields.

IBRA Regions
Swan Coastal Plain, Coolgardie.

NRM Regions
Swan, Rangelands.

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

SPP # 2004/0001

Team members
A Wills (0.20), I Abbott (0.01), A Mellican (0.02); Total (0.23).

Context
As ecosystem engineers, earthworms contribute to and are sensitive to fundamental ecological processes. Understanding the status of earthworms in reserve systems is important for understanding effects of processes threatening fragmented ecosystems and developing ecologically appropriate strategies for long-term conservation of locally endemic invertebrates. Earthworms are one of the few invertebrate groups that are seen as beneficial by the public. Thus improved

knowledge about native earthworms on the Swan Coastal Plain, where most Western Australians live, should help improve community understanding of the key roles of invertebrates in providing ecosystem services.

This study aligns with KRA 2 (NC 2B), KRA 3 (NC 3C), KRA 4 (NC 4C) and KRA 6 (NC 6A).

Aims

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

Summary of progress and main findings

- 40 sites were sampled between Bunbury and Mandurah in July and August 2005.
- Limited sorting and identification done.

Management implications

- Development of an appropriate conservation strategy for earthworm fauna on the Swan Coastal Plain based on a dynamic ecosystem perspective.

Future directions (next 12-18 months)

- Continue to collect samples in July and August 2006 and 2007.
- Continue identification of specimens.

DEC Regions
Swan, South West.

IBRA Region
Swan Coastal Plain.

NRM Region
Swan.

FLORA CONSERVATION AND HERBARIUM

Program Leader: Dr David Coates

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 (0.2), N Gibson (0.05) B Macdonald (0.4), S McArthur (0.1); Total (1.05).

Context

The flora of Western Australia is complex due to the antiquity of the landscape and this can lead to obscurity in taxonomic identity, which impacts on conservation status of rare and threatened taxa. Genetic analysis can inform the conservation and biosystematics of these taxa.

It aligns with Corporate Priorities 5 and 12, NC KRA 4 and NC 4C.

Aims

- To provide genetic information for the conservation and management of Western Australian flora, especially rare flora.
- To determine the genetic diversity between the 2 subspecies of *G. curviloba* to inform taxonomic status.
- To determine taxonomic identity of populations in the *Synaphea stenoloba* complex.
- To determine level of differentiation between populations of *Eremophila microtheca* and *E. rostrata* to inform taxonomic status.
- To determine the level of differentiation in *Calothamnus quadrifidus* to assist in the taxonomic revision of the group.
- To determine the level of differentiation in *Dryandra mimica* and *Pultenaea pauciflora* to assist in the taxonomic revision of the group
-

Summary of progress and main findings

- *G. curviloba* – investigation of genetic diversity within and between the 2 subspecies has shown little differentiation between them and does not support their recognition as separate subspecies. Extensive clonality was observed in all populations of *G. curviloba*.
- *Synaphea* sp. –AFLP genotypes have been obtained for 25 populations representing 8 putative taxa. Data analysis is currently underway.
- *Eremophila microtheca* and *E. rostrata* – DNA extractions have been made for collections from the known populations and appropriate outgroups. Microsatellite markers are being tested.
- *Calothamnus quadrifidus* – Genotyping of individuals from 40 populations throughout the range from Shark Bay to Esperance is currently underway.
- *Tetratheca* sp. - Taxonomic revision of the leafless *Tetratheca* species in the Koolyanobing area has been published in Australian Systematic Botany.
- Review 'Phylogeography provides an evolutionary context for the conservation of a diverse and ancient flora' has been published in Australian Journal of Botany.

Management implications

- 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.
- Assessment of the genetic structure within collections of *Synaphea* from the Pinjarra Plains will

inform taxonomic revision and determine identity of questionable populations of the DRF taxa.

- Assessment of genetic differentiation in *E. microtheca* and *E. rostrata* will assist in determination of sub-specific taxa, and clarification of DRF status.
- Assessment of genetic differentiation in *C. quadrifidus* will enable taxonomic revision of the group and identification of rare taxa.

Future directions (next 12-18 months)

- Report and journal paper on the genetic status of the subspecies in *G. curviloba* will be written.
- Journal paper on *E. bennettiae* as a hybrid between *E. sporadica* and *E. lehmannii* will be written.
- Analysis of *Synaphea* sp. will be completed to resolve the taxonomic identity of populations.
- Analysis of *E. microtheca* and *E. rostrata* will be completed to determine possible subspecies status within each species.
- Assessment of genetic structure within *Calothamnus quadrifidus* and allied taxa will be undertaken to inform taxonomic revision of the group.
- Commence study on *Laxmannia jamesii.*
- Commence study on *Lambertia fairallii*.
- Genetic differentiation between populations of *Dryandra mimica* will be determined.
- Genetic differentiation between populations of *Pultenaea pauciflora* will be determined.

DEC Regions

South Coast, Midwest, Swan, Wheatbelt, Goldfields.

IBRA Regions

Geraldton Sandplains, Esperance Plains, Swan Coastal Plain, Avon Wheatbelt, Yalgoo, Coolgardie, Mallee, Murchison.

NRM Regions

Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

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), T Llorens (0.6), S McArthur (0.3), H Nistleberger (1.0), Total (2.5).

Context

A priority for long-term conservation of remnant vegetation is the maintenance of viable plant populations. However, little is currently known about what biological factors actually affect population persistence. This project quantifies genetic and ecological factors that influence the viability of plant populations in fragmented WA agricultural landscapes and explores how these are affected by remnant vegetation characteristics such as size, isolation, disturbance and landscape position.

It aligns with Corporate Priorities 3, 5 and 12, NC KRA 3, 4 and sub outputs NC 3G, 4C.

Aims

- 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

- Paper published on 'Gene flow and outcrossing in a fragmented landscape: implications for seed sourcing from small remnants, initial analyses of mating systems and gene flow in *Calothamnus quadrifidus* and *Eucalyptus wandoo'.*
- Paper published in *Biological Conservation* on 'Seed production, germinability and seedling growth for a bird pollinated shrub in fragments of kwongan in south-west Australia'
- Paper published in *Biodiversity and Conservation*. 'Bird pollination and mating system variation for the shrub in fragments of species rich kwongan in south-west Western Australia'.
- Paper on Gene flow in *E. wandoo* published in *Conservation Genetics*.
- Paper on Gene flow in *C. quadrifidus* published in *Molecular Ecology*.
- Population size and to a lesser extent population isolation have been confirmed as key variables that will significantly influence the persistence of plant populations in remnant vegetation following fragmentation. In the case of both the bird pollinated *C. quadrifidus* and the insect/bird pollinated *E. wandoo* reproductive output in the form of seeds produced per fruit is dramatically reduced in small populations.
- A second key outcome from this study is the level of gene (pollen) flow into small isolated populations of both *C. quadrifidus* and *E. wandoo*. Although significant connectivity is not apparent across large sections of the Dongolocking landscape the importance of single trees or very small remnants as facilitators of pollen movement is evident. In particular, the high level of pollen movement into small isolated *E. wandoo* populations from at least 1km away appears likely to be a key factor in maintaining outcrossing rates, reducing inbreeding and maintaining seed production levels. A significant factor in ensuring gene flow between *E. wandoo* populations in this landscape will therefore probably depend on the maintenance of spatially critical paddock trees and small remnants.
- Phase 2 Site selection for a *Banksia sphaerocarpa* gene flow study has been completed.

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 directions (next 12-18 months)

- Complete Phase 2 analysis of site/population characteristics – disturbance, density and isolation.
- Complete Phase 2 seed set/reproductive output studies.

- Commence Phase 2 genetic variation studies and gene flow studies.
- Continue preparation of 8 publications from phase 1 of the project.
- Write papers on: mating system variation and reproductive output in *Eremaea pauciflora*, genetic diversity in *E. wandoo* and genetic diversity in *C. quadrifidus*.

DEC Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Regions
Avon, Northern Agricultural, South Coast, Swan.

Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance
SPP # 2001/001

Team members
D Coates (0.2), M Byrne (0.1); S. McArthur (0.1); Total (0.4).

Context
Understanding the interactions between mating systems, levels of inbreeding and patterns of genetic variation within populations of species is a key element in assessing the viability of plant populations, particularly rare and threatened taxa, and the development of management strategies that will reduce the likelihood of local extinction.

It aligns with Corporate Priorities 5 and 12, NC KRA 4 and sub outputs NC 4C, 4F.

Aims
- 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 *Conservation Genetics* on 'Reduced genetic diversity and increased inbreeding in the rare *Acacia sciophanes* compared with its sister species *Acacia anfractuosa*'.
- Draft paper in preparation on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis* subsp*. Fimbrilepis*'.
- Paper published in the *Australian Journal of Botany* on 'Plant mating systems and assessing population persistence in fragmented landscapes'. Findings from this work show that changes in the mating system can be useful indicators of population processes and can give valuable insight into the development of conservation strategies for plant species persistence following anthropogenic disturbance and landscape fragmentation.
- Paper published in *Australian Journal of Botany* which includes a study on population genetic structure in the critically endangered *Verticordia staminosa.*

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 directions (next 12-18 months)

- Finalize paper on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis ssp. Fimbrilepis*'.
- Complete temporal mating system data analysis on *Banksia cuneata*.
- Complete genetic structure study on *Banksia brownii.*

DEC Regions

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

IBRA Regions

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

NRM Regions

Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

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), V Cunningham (1.0), T Erickson (1.0), N. Sheehy (1.0), D Coates (0.05); Total (5.05).

Context

Seed conservation is a specific and targeted action to conserve biodiversity and entails the storage of genetic material in the form of seed. This material is available for *in situ* recovery actions, and seed research. Understanding the seed biology of plant species is important for the conservation and management of rare and threatened Western Australian taxa and for developing and implementing recovery plans for the flora.

It aligns with Corporate Priority 5 and 12, NC KRA 3, 4, 6 and sub outputs NC 3G, NC 3H, NC 3L, NC 4C, NC 6A.

Aims

- 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, ecology and longevity 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 221 rare, threatened, poorly known and other taxa were made (259 accessions). This included 73 DRF, 83 Priority and 103 general collections of taxa associated with threatened ecological communities and biodiversity hotspots. A further 83 collections have been donated to the TFSC for cleaning and storage. These collections included 30 DRF, 4 Priority and 49 general collections.
- 128 collections were duplicated with the Millennium Seed Bank Project representing 59 genera in 30 families.
- Seeds of 7 species collected and stored ex situ by the TFSC have been used in translocations in the past year.
- Through the *ex situ* seed conservation and translocation programs, Western Australia has reached the goals of Target 8 of the Global Strategy for Plant Conservation for 2010 (60% of Threatened flora in ex situ collections and 10% used in recovery).
- Three seed-related papers were published in the Australian Journal of Botany: 'Seed quality for conservation is critically affected by pre-storage factors' by R Probert, J Adams, J Coneybeer, A Crawford and F Hay; 'Analysis of seed bank data confirms suitability of international seed storage standards for the Australian flora' by A Crawford, K Steadman, J Plummer, A Cochrane and R Probert and 'The significance of ex situ seed conservation to threatened plant reintroduction' by A Cochrane, A Crawford and L Monks.
- All data pertinent to the collection, testing, storage and monitoring of seed-based data has been entered into the WASEED database, which continues to be updated.

Management implications

- Improved conservation of threatened and endemic plant taxa.

Future directions (next 12-18 months)

- Ongoing collection of seed for incorporation into the gene bank, including DRF and priority taxa, and common species associated with threatened ecological communities and biodiversity hotspots.
- Ongoing research into the seed biology and seed storage behaviour of a number of threatened plant taxa.
- Germination testing, storage and monitoring of existing accessions.
- Continuation of Phase 2 of international collaboration with Millennium Seed Bank Project, UK with increased seed collection targets and science research collaboration, including PhD by A Crawford.
- Reporting requirements to SCRIPT (cross regional NHT project) and MSB Kew.
- Research into germination temperature thresholds for south west Western Australian taxa has commenced.
- Other publications.

DEC Regions

All.

IBRA Regions

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

NRM Regions

Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

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

SPP # 1997/0002

Team members

G Keighery (0.2), W Muir (0.05); Total (0.25).

Context

Understanding the nature and extent of feral plants in native and agricultural systems of Western Australia. Use these data to establish clear State and Federal priorities for weed management that are aligned to WA needs and major weed issues.

Aligns with Corporate Priorities 3, 5 and 12, KRA 2, 3 and sub output NC 2A and NC 3C.

Aim

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

Summary of progress and main findings

- Presented review of Bulbous weeds of WA at Bulbous weeds workshop.
- Reviewed; Weedy grasses of conservation concern in Western Australia at Grass Weed Workshop, Wednesday, 20th of September 2006.
- Western Weeds 2; a field guide to the Weeds of Western Australia (in print).
- Major NRM grant obtained (Number 20-0608) for Strategic weed management in Swan NRM Region. Database prioritizing all weeds of region prepared, work-shopped.
- Sharp Rush Workshop held. Proceedings of Sharp Rush Symposium in press.
- Continue on assessment panel for remote weed projects by fire crews.
- Landscope article *War on Weeds* with Kate Brown on BCI initiative published.
- Reviewed, collected weeds of Pilbara Bioregion.
- Note detailing potential weed problems in planting non local species and forms of *Calothamnus* published in WA Wildflower Society Newsletter.
- Present and participate in DEC Weed Training Workshop.

Management implications

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

Future directions (next 12-18 months)

- 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.
- Joined WONS working group on Willows, ANZEEC Group for weeds of conservation concern and reviewing Rottnest weed and rehabilitation plans.
- Paper on Bulbous weeds accepted for International weeds symposium.
- Present and produce review of Geraldton Carnation weed for DEC workshop.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

Experimental translocation of Critically Endangered plants

SPP # 2001/0004

Team members

L Monks (0.9), S Thomas (1.0), D Coates (0.05); Total (1.95).

Context

In order for translocations of threatened flora to contribute to the successful recovery of species it is important that best practice techniques are developed and there is clear understanding of how to assess and predict success.

The flora translocation program aligns with Corporate Priorities 5,12, NC KRA 4, sub-output NC 4C.

Aims

- 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

- Translocations of 6 Critically Endangered plants were commenced involving the establishment of new populations at 2 sites for each species as part of the Save Our Species Initiative.
- 23 translocations planted in previous years were monitored.
- Ongoing monitoring of translocations is providing information on the success of methodologies used and the probability of long-term success. Close collaboration with District and Regional staff on this project then enables this information to be utilized immediately in other flora translocation projects.
- Ongoing development of flora translocation database continuing in collaboration with WA Threatened Species and Communities Unit.
- Completed draft paper for mating systems study on *Lambertia orbifolia* translocation, commenced writing paper of Acacia translocation success.
- Published a paper in the Australian Journal of Botany on 'The significance of *ex situ* seed conservation to threatened plant reintroduction'.

Management implications

- Improved conservation status for critically endangered plant taxa.
- Improved awareness of best practice translocation methodologies for DEC staff and communities members undertaking such work.

Future directions (next 12-18 months)

- Finalize stage 2 of the translocation of 6 Critically Endangered plants as part of the Save Our Species Initiative.
- Continue the planting of experimental translocations of 23 critically endangered plant species where further plantings are deemed necessary.
- Continued the monitoring of the 23 translocations and analyses of population biology data.
- Publish translocation methodology data, *Lambertia orbifolia* mating systems study, and Acacia translocation success study.
- Finalize development of rare flora translocation database.

DEC Regions
Midwest, South Coast, South West, Swan, Wheatbelt.

IBRA Regions
Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren.

NRM Regions
Avon, Northern Agricultural, South Coast, South West, Swan.

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).

Context
Understanding long-term effects of control of *Phytophthora cinnamomi* by phosphite application is important for developing and implementing ecologically appropriate control options for the management of *P. cinnamomi*. This study, established in 1979, was designed as a series of long-term experiments.

It aligns with Corporate Priorities 3, 12, NC KRA 2 and 3 and sub-outputs NC 2B, NC 3I, NC 3L, NC 4C and PVS 5F.

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
- With funding from NHT in 2003/004 grouped plant species in a jarrah forest site and south coast site into either phosphite non-responsive, such as *Lambertia inermis,* and phosphite responsive, such as *Banksia grandis.*
- Determined inter-specific differences in phosphite effectiveness within *Lambertia*. Phosphite was not effective in all *Lambertia* species. Re-testing is progressing using a different testing method.
- Phosphite stem and aerial application techniques were compared in 2006.

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

Future directions (next 12-18 months)
- Prepare for publication injection and spray trials.

DEC Regions
South West, South Coast.

IBRA Regions
Esperance Plains, Jarrah Forest, Swan Coastal Plain.

NRM Regions
Avon, South Coast, South West, Swan.

Susceptibility of rare and endangered flora to *Phytophthora*

SPP # 1999/0019

Team members

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

Context

Determination of the susceptibility of threatened flora to *Phytophthora cinnamomi* is important for prioritizing flora at risk of infection and implementing ecologically appropriate control options for the management of *P. cinnamomi*. This study, established in 1996, was designed as a series of yearly testing of threatened flora as germinants become available from the Threatened Flora Seed Centre.

It aligns with Corporate Priorities 3, 12, NC KRA 2 and 3 and sub-outputs NC 2B, NC 3I, NC 3L, NC 4C and PVS 5F.

Aims

- 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 137 taxa for susceptibility in 2006.
- To date 50+ taxa transferred to pots for testing in 2007.
- Database of 200 + taxa updated.
- Provisional susceptibility list distributed within DEC.
- Test *Lambertia* species for within species variation in susceptibility.

Management implications

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

Future directions (next 12-18 months)

- Plant up germinates as received from Threatened Species Seed unit throughout 2007.
- Inoculate plants in 2008 and record mortality.
- Update database.
- Test survivors for root infection.

DEC Regions

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

IBRA Regions

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

NRM Regions

Avon, South Coast, South West, Swan.

The use of high intensity phosphite techniques to control *Phytophthora cinnamomi*

SPP # not yet allocated

Team member
C Dunne (1.0).

Context

- Determination of the biology and epidemiology of *Phytophthora cinnamomi* in the South Coast Region is important for implementing appropriate management options for the control of *P. cinnamomi*. Further, understanding of the efficacy of high intensity phosphite for the control of P. cinnamomi would provide more options for the management of infested areas.
- This aligns with Corporate Priority 3, 5, 12, NC KRA 2 and 3 and sub-outputs NC 2B, NC 2I, NC 3I, NC 3L and PVS 5F.

Aims

- To advance our understanding of disease biology and epidemiology of *Phytophthora cinnamomi* in the native plant communities within the National Parks of the South Coast Region of Western Australia.
- To demonstrate the use of novel phosphite control techniques to reduce the impact of *Phytophthora cinnamomi* within the Threatened Ecological Communities of the Stirling Range National Park and Bell Track infestation in the Fitzgerald River National Park.

Summary of progress and main findings

- Sites selected and field trials established
- Ongoing monitoring of spatial and temporal variation in the soil population dynamics of P. cinnamomi.

Management implications

- Improved efficacy of phosphite treatment to control *P. cinnamomi*.
- Increased understanding of disease epidemiology will allow for more accurate modeling of disease centre extension.
- Improved management of *P. cinnamomi* through the use of appropriate hygiene practices.

Future directions (next 12-18 months)

- Continue monitoring of spatial and temporal variation in the soil population dynamics of *P. cinnamomi.*
- Monitor the efficacy of high intensity phosphite to prevent disease centre extension and minimize impact of *P. cinnamomi*.
- Conduct research into the conduciveness of soils from the South Coast Region on the infection of susceptible hosts by *P. cinnamomi*.

DEC Region
South Coast.

IBRA Region
Esperance Plains.

NRM Region
South Coast.

Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*
SPP # 93/0112

Team member
M Stukely (0.15).

Context

Genetically-based resistance to *Phytophthora cinnamomi* (Pc) has been demonstrated in jarrah (*Eucalyptus marginata*). A long-term selection and screening program has been carried out by means of inoculation trials and subsequent field validation trials to prove the selections. Selected individuals showing the highest levels of resistance have been selected from those half-sib jarrah families that showed the best overall Pc-resistance levels. These seedlings have been propagated and multiplied by tissue-culture. The resulting clonal lines have been used in validation trials, in field plantings, and to establish Seed Orchards for the production of Dieback Resistant jarrah (DRJ) for future operational forest rehabilitation plantings.

The project aligns with Corporate Priority 3, 12, NC KRA 3 and sub-outputs NC 3L.

Aims

- 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 DEC/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

- A journal paper on the field validation of clonal DRJ was published (see below). The project will now be closed, with plots retained for long-term monitoring. It is being replaced with a new research project investigating aspects of dieback and the formulation of jarrah forest silviculture guidelines, aligned with SFM goals (KRA 3 – SFM 3A, SFM 3O, also NC 3L). A Science Project Concept Plan has been approved and the SPP was submitted for approval.
- A journal paper arising from the PhD project of Margaret Wheeler (Murdoch University) was completed and is currently under review: 'Intraspecific variation in seed viability and seed production in clones and wild trees of *Eucalyptus marginata* (Myrtaceae)' [amended title]. Two conference posters from this project are in preparation.

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 19 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 early drought deaths were recorded at both sites. There were minimal additional losses in 2002-07.
- A paper was published in 'Forest Ecology and Management': 'Field survival and growth of clonal, micropropagated *Eucalyptus marginata* selected for resistance to *Phytophthora cinnamomi*.'

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

- No further infill planting has been done since 2004 due to unavailability of clones; the total number of unrelated DRJ lines planted in the seed orchard to date is 29.
- DRJ clones will be produced at Alcoa's lab for final infill planting by FPC, to reach the goal of 35 DRJ lines and complete the seed orchard.
- The first seed crop has been collected from the orchard (FPC).

Management implications

- Now that seed production has started in the seed orchard, DRJ seedlings will be grown in the nursery and made available to DEC 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, across the range of jarrah.

Future directions (next 12-18 months)

- The project will now be closed [field plots will be retained for long-term monitoring].
- Infill planting of DRJ Seed Orchard at Manjimup PPC will be done by FPC when clones are available from Alcoa.
- Future research relating to the DRJ Seed Orchard will necessarily include initial quality-control testing (inoculation trials) of its progeny for Pc resistance and culling as required; also 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.

DEC Regions

Warren, South West, Swan, Wheatbelt.

IBRA Regions

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

NRM Regions

Avon, South Coast, South West, Swan.

Dieback-resistant jarrah establishment in operational forest rehabilitation sites

SPP # 94/0006

Team member

M Stukely (0.05).

Context

Operational Dieback Forest Rehabilitation (DFR) plantings will desirably include Dieback Resistant jarrah (DRJ), i.e., lines of jarrah that have been selected for their genetic resistance to *Phytophthora cinnamomi* (SPP 93/0112). Seedling DRJ will be available for operational plantings when the DRJ seed orchard (SPP 93/0112) becomes productive. During the 1990s, trial plantings of clonal Dieback Resistant jarrah (DRJ) were established in operational forest rehabilitation sites in several DEC Districts. While survival was good at some sites, it was often very poor on the harsher sites, such as the Black Gravels. Due to the high cost of producing DRJ clones, and difficulties with re-establishing clonal jarrah in forest sites, it was decided that the clones will now be used to establish managed DRJ seed orchards (see SPP 93/0112), rather than directly planting them into operational forest rehabilitation sites. A new approach addressing the broader problem of poor survival of eucalypt seedlings in DEC's operational Dieback Forest Rehabilitation sites was started in 2003, with support from Alcoa and in collaboration with Perth Hills District.

The project aligns with Corporate Priority 3, 12, KRA 3 and sub-outputs NC 3L.

Aims

- To re-establish jarrah, initially using clonal, dieback-resistant plants, in operational Dieback Forest Rehabilitation (DFR/FIRS) sites.
- To test a range of site treatments aimed at maximizing the survival of seedlings planted in dieback graveyard sites.

Summary of progress and main findings

- Overall there was a very high level of survival of both seedlings and DRJ clones in the 2004 trial at Willowdale on a graveyard site including black gravel and sheet laterite caprock. Probing of the soil to 40cm prior to planting was done for all trees to ensure adequate soil depth for root

penetration. Seedlings and clones were also planted deeper than usual. The novel use of 10-metre wide strip-plantings, running north-south to provide some shading and wind protection, rather than planting in a single, open, broadscale area, was also beneficial. Trees that were watered through the first summer (watering was done when no rain had fallen for at least 3 weeks) showed better survival than non-watered trees. However, the application of mulch and slow-release fertilizer at a low rate made no difference to survival.

Management implications

- The site preparation and seedling treatments giving the best seedling survival rates will be applied to routine forest rehabilitation (DFR) procedures for the re-establishment of jarrah in degraded sites across the range of jarrah, including forest graveyard sites, clearings, log landings and tracks. The treatments will be applied to the dieback-resistant progeny from the DRJ seed orchard (SPP 93/0112) when these become available for operational-scale planting. These treatments will also be applicable for the establishment of marri in these sites.

Future directions (next 12-18 months)

- A journal paper is in preparation for publication.
- The project will then be closed.
- Advice will be provided on the design and treatments for a final trial to be set up by Alcoa and Perth Hills District to determine the combination of treatments for optimum jarrah seedling survival in the Black Gravel sites, based on the results achieved in this project so far.

DEC Regions
South West, Swan.

IBRA Region
Jarrah Forest.

NRM Regions
Avon, South Coast, South West, Swan.

Mundulla Yellows disease in Western Australia

SPP # not yet allocated

Team member
M Stukely (0.15).

Context
Mundulla Yellows (MY) is a lethal disease of eucalypts that appears to be well established in various disturbed sites in WA (and in all other states). Over 50 species of eucalypt are affected. The cause of MY is unknown, but there is evidence that a virus or similar organism(s) is involved. Priority research (now being carried out in SA and Victoria) includes determining the cause(s) of MY and its mechanisms of spread, and the development of a rapid diagnostic test for the disease. If it is caused by an infectious pathogenic agent, MY has the potential to cause enormous environmental damage if it progresses unchecked. Both remnant and planted trees of all ages can be affected. Once its cause, mechanisms of spread and contributing factors are known, the levels of threat posed to vegetation can be estimated and management strategies can be developed to control the disease and prevent its spread to new areas.

The project aligns with Corporate Priority 3, 12, KRA 2, 4, 6, sub-outputs NC 2A, NC 2B, NC 4C.

Aims

- 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 2004-2006).

Summary of progress and main findings

- Monitoring of MY in WA by DEC has continued, in collaboration with Dr D Hanold, Dr N Thompson and Prof J Randles (University of Adelaide). Several reports of possible MY-affected trees have been received from DEC staff, and these have been checked and sampled. New occurrences have been recorded in the Collie, Boyup Brook, Bridgetown and Busselton areas.
- A 3 year ARC Linkage Grant, with DEC as an Industry Partner, concluded in March 2007 - 'A comparative study of the distribution and spread of potential molecular markers for Mundulla Yellows disease.' A possible new molecular marker for MY was discovered and investigations are continuing. [MY-RNAs are now not considered to be a consistent marker.]
- Seedlings are being grown on in the glasshouse for testing in transmission trials set up in 2006.
- MY symptoms have been recorded in WA in remnant *Eucalyptus marginata, E. todtiana, E. rudis, E. camaldulensis, E. salmonophloia, E. loxophleba, E. pleurocarpa* 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 (e.g. *E. botryoides, E. cladocalyx, C. citriodora, C. maculata*). Samples have been sent to Dr Hanold in Adelaide to be tested for MY-RNAs and other potential markers.
- MY-RNAs have been detected in symptomatic trees of those species for which the present molecular test (Hanold & Randles) can be used - *E. camaldulensis, E. rudis, E. salubris, E. salmonophloia, E. loxophleba, E. gomphocephala* and *Corymbia calophylla*. These species will now need to be tested for other markers.
- Soil and foliar samples have been collected from MY-affected and asymptomatic eucalypts at a variety of sites, and chemically tested. Soil pH levels under MY-affected trees in WA range from strongly acidic to mildly alkaline. This conflicts with recent data reported from Victoria, where only strongly alkaline soils have been implicated.
- MY-affected trees have been recorded by M Stukely from Northampton to Esperance. They occur on disturbed sites including roadsides, parks and gardens, and symptoms have also been observed in remnant paddock trees several hundred metres from the nearest road. However, affected trees have still not been observed within undisturbed forest or woodland stands.
- Symptom development in affected trees can be rapid once the dieback phase begins.
- Spread of MY symptoms between trees at any given site does not appear to be rapid; however, the number of known affected sites is still increasing. Numbers of affected trees at most newly observed sites are small.
- The national Mundulla Yellows Task Group (MYTG) 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. The group now continues informally for consultation and discussion, and M Stukely has continued to represent DEC and WA there.

Management implications

- If it is caused by an infectious pathogenic agent, MY has the potential to cause enormous environmental damage if it progresses unchecked. Both remnant and planted trees of all ages can be affected.
- Once its cause, mechanisms of spread and contributing factors are known, the levels of threat posed to vegetation can be estimated; and
- Management strategies can be developed to control the disease and prevent its spread to new areas.

Future directions (next 12-18 months)

- Continued monitoring of existing and new occurrences of MY in Western Australia.
- Prepare scientific paper on soil and foliar nutrient data for publication.
- Complete seedling transmission trials in the glasshouse (DEC in-kind contribution to the ARC Linkage Grant).
- Further education of DEC and FPC staff in relevant areas in identifying and reporting possible MY symptoms.
- Continued collaboration with, and assistance to, Dr Hanold and the Adelaide researchers.

- Additional field transects are to be established in WA for monitoring spread of MY from known infections to healthy vegetation.

DEC Regions

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

IBRA Regions

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

NRM Regions

Northern Agricultural, Swan, Avon, South West, South Coast, Rangelands.

Vegetation Health Service

Core Function

Team members

M Stukely (0.35), J Webster (0.6), J Ciampini (0.4); Total (1.35).

Context

Accurate knowledge of the *Phytophthora* infestation status of particular land units and sites (and adjacent areas), and of its variation over time, is essential and crucial for effective land management and biodiversity conservation. The Vegetation Health Service (VHS) provides a dedicated, specialist scientific service for the detection and identification of *Phytophthora* species from samples associated with the management of the State's forest and conservation estate, logging and mining activities, private industry and research. The VHS is also a service contributor to the Centre for *Phytophthora* Science and Management based at Murdoch University.

This scientific service aligns with Corporate Priority 3, 12, KRA 2, 3, 4, 6 and sub-outputs NC 2A, NC 2B, NC 3L, NC 4C.

Aims

- 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 1544 samples were processed for *Phytophthora* between 1st July 2006 and 31st May 2007, and all isolates of *Phytophthora* spp. (other than *P. cinnamomi*) were subcultured for identification to species.
- Unusual *Phytophthora* isolates were again sent to the Centre for *Phytophthora* Science and Management based at Murdoch University for DNA analysis. This service is now available on a regular basis.
- DNA sequencing of new *Phytophthora* isolates, as well as historical isolates from the VHS culture collection, has shown at least 7 new and undescribed *Phytophthora* taxa to be established in WA's natural ecosystems. Conference poster presentations on these findings are in preparation.
- A PhD student project (Alex Rea) commenced in April 2007 at Murdoch University to investigate aspects of these new *Phytophthora* taxa: 'Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species.'
- An undescribed *Phytophthora* sp. (P.sp.WA2), that has been found with unexpectedly high frequency in association with dying plants since 2003, was again found. While it is

morphologically similar to *P. citricola*, its ITS-rDNA sequence is quite distinct, and suggests a separate species. An Honours student project (M Bexley) started in 2006 at Murdoch University ('Biology and pathology of *Phytophthora citricola*-like organism') was not completed, but the work will be incorporated into the new PhD project (see above).

- A paper reporting this new species (P.sp.WA2) was published in 'Australasian Plant Disease Notes'.
- *Phytophthora inundata*, a recognized pathogen of woody trees and shrubs named in 2003 in the UK, has again been isolated from dying native vegetation in WA.A journal paper reporting the isolation of this species was prepared, and is under review.
- A presentation was given at the 2006 Dieback Information Group (DIG) Conference: 'New *Phytophthora* species in WA.'
- Dr C Dunne (DEC) has used the VHS facilities for the BCI – *Phytophthora* project. The services and facilities of the VHS were also made available through the Centre for *Phytophthora* Science and Management to 2 PhD student projects, at Murdoch University.
- An Annual Report on *Phytophthora* detection by the VHS in 2005-06 was distributed within DEC.
- Advice was given for the *Phytophthora* Management theme of the Biodiversity Conservation Initiative (BCI), and the VHS is assisting with related projects.
- Advice and consultations concerning other plant diseases were given to various DEC staff and members of the public as required, including several NatureBase inquiries.

Management implications

- Accurate testing of samples for *Phytophthora* by the VHS 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.
- The availability of DNA sequencing technology through the Centre for *Phytophthora* Science and Management means that it is now possible to identify sterile *Phytophthora* isolates that cannot be identified using traditional morphological techniques, and also to differentiate between morphologically similar but genetically quite distinct taxa that have previously been grouped and treated as single species. Knowledge of the pathogenicity, distribution and environmental requirements of these new and different Phytophthoras is essential to enable estimates to be made of the level of threat they pose to biodiversity, and for strategies for their monitoring, management and control to be developed. It may not be appropriate to treat all Phytophthoras in the same way as *P. cinnamomi.*
- Advice provided on other plant disease problems will assist in the management of these problems.

Future directions (next 12-18 months)

- 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 facilities and culture collection will continue to be available for use by the Centre for *Phytophthora* Science and Management, at Murdoch University, and to assist student projects.
- The VHS will continue to contribute to and assist with projects under the *Phytophthora* Management theme of the Biodiversity Conservation Initiative (BCI).
- Further work will be done on the recently isolated *Phytophthora* spp. nov., with a view to publishing these. A paper is to be completed and published on *P. inundata* in WA. Conference posters will be presented.
- The *Phytophthora* Culture Collection and WA *Phytophthora* database will be maintained and expanded, and available to researchers.
- Supervision of the PhD student project (Alex Rea) at Murdoch University will continue, and additional student projects will be initiated under joint supervision with the Centre for *Phytophthora* Science and Management to investigate undescribed and newly recorded

Phytophthora taxa and their role in native ecosystems, with a view to the early introduction of monitoring and management strategies where necessary.

- Testing for Mundulla Yellows disease in WA will be co-ordinated through the VHS, when a routine diagnostic test becomes available.

DEC Regions

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

IBRA Regions

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

NRM Regions

Northern Agricultural, Swan, Avon, South West, South Coast.

The population ecology of Critically Endangered flora

SPP # 2000/015

Team members

C Yates (0.6).

Context

Understanding the interactions between fragmentation and small population processes, fire regimes, weed invasion and grazing regimes is critical for conservation and management of Declared Rare Flora and Threatened Ecological Communities.

The project aligns with Corporate Priority 5, 10 and 12, KRA 2, 3 and 4 and sub-outputs NC 2B, NC 3K and NC 4C.

Aim

To determine the critical biological factors and the relative importance of contemporary ecological interactions and processes that limit population viability and persistence of Declared Rare Flora, particularly Critically Endangered Species and other key plant species occurring in Threatened Ecological Communities.

Summary of progress and research findings

- Continued monitoring the effect of fire interval on plant species richness and abundance in the Critically Endangered Eastern Stirling Range Montane Heath and Thicket community.
- Continued monitoring the demography of DRF and other taxa of conservation significance in the Critically Endangered Eastern Stirling Range Montane Heath and Thicket community.
- Completed population viability analyses examining the effect of different fire regimes on the persistence of *V. fimbrilepis* populations in wheatbelt remnant vegetation, and submitted manuscript to Australian Journal of Botany.
- Hierarchies of cause: understanding rarity in an endemic shrub, *Verticordia staminosa* ssp. *staminosa* with a highly restricted distribution - manuscript published in Australian Journal of Botany.

Management implications

- The research in the Eastern Stirling Range Montane Heath and Thicket Community is yielding valuable information about the impact of fire interval on floristic diversity, fire response strategies and life histories of DRF and other vascular plant species. This will contribute to the development of ecologically appropriate fire regimes.
- Prescribed fire will be needed to maintain populations of *V. fimbrilepis* subsp. *fimbrilepis* in habitat fragments.

- Under current conditions the only known population of *V. staminosa* subsp. *staminosa* is stable and ongoing management should focus on protecting adult plants because of the large contribution stasis makes to population stability. If continued monitoring shows increases in adult mortality we should be concerned, fire may be particularly important in this respect. If predictions from climate change models of decreased rainfall in the south west Australia are correct the taxon may be less secure and the practicalities of translocation to other granite outcrops may need investigation.

Future directions (next 12-18 months)

- Continue to monitor the Fire Ecology of the Eastern Stirling Range Montane Heath and Thicket Community.
- Work with DEC Great Southern District to implement a fire management plan for *V. fimbrilepis* subsp. *fimbrilepis.*

DEC Regions

South Coast, Swan, Wheatbelt.

IBRA Regions

Avon Wheatbelt, Jarrah Forest, Esperance Plains.

NRM Regions

Avon, South Coast, Swan.

Causes of rarity in 4 *Tetratheca* taxa in the goldfields ranges

SPP # not yet allocated

Team members

C Yates (0.2), N Gibson (0.2), R Palmer (0.75), N Petit (0.25); Total (1.4).

Context

The Eastern Goldfields Ranges are local hotspots of plant diversity with many endemic taxa. This project centres on the critically endangered *Tetratheca paynterae* ssp. *paynterae* found at Portman Iron Ore Ltd's Windarling mine, and 3 other threatened *Tetratheca* taxa on adjacent ironstone ranges with mining prospectives; *Tetratheca paynterae* ssp. *cremnobata* found on the Diehardy Range; *Tetratheca harperi* found on the Mount Jackson Ranges; and, *Tetratheca aphylla* found at the Helena and Aurora Ranges. The project is investigating the environment, reproductive biology and demography of the ironstone *Tetratheca* taxa.

The project aligns with Corporate Priority 5 and 12, KRA 4 and sub-output NC 4C.

Aim

- To investigate the reproductive biology and demography of rare *Tetratheca* taxa impacted by mining. Model the distribution patterns of the 4 *Tetratheca* taxa to determine environmental drivers of rarity and aid selection of possible translocation sites.
- To provide population viability models for the 4 *Tetratheca* taxa. Describe floristic composition of upland communities on the 4 ironstone ranges.

Summary of progress and research findings

- Modelled the environments of the 4 *Tetratheca* taxa.
- Modelled species composition of upland plant communities on each of the ironstone ranges where the 4 *Tetratheca* taxa occur.
- Measured population demography, for the third year, and rates of pollination and reproduction for the fourth year for each of the 4 *Tetratheca* taxa.

Management implications

- The comparative investigations of the 4 taxa will elucidate why adjacent ironstone ranges each have an endemic *Tetratheca*, rank the biological factors that are most important for maintaining viable populations, assist in assessing the impact of mining on *T. paynterae* subsp. *paynterae*. The description of the floristic composition of upland plant communities will further understanding of phytogeographic patterns on banded ironstone ranges in the Eastern Goldfields.

Future directions (next 12-18 months)

- Continue measurements of population vital rates for each of 4 taxa.
- Construct demographic models and begin population viability analysis of *T. paynteare* ssp*. paynterae.*
- Write up research on environments and reproductive biology of the 4 *Tetratheca* taxa.
- Write up research on floristic composition of upland plant communities on each of the 4 ironstone ranges.

DEC Region
Goldfields.

IBRA Region
Coolgardie.

NRM Region
Rangelands.

Taxonomic studies on native and naturalized plants of Western Australia arising from biological survey

Concept Plan submitted

Team member
G Keighery (0.1).

Context
Many Declared Rare Flora have nomenclatural and taxonomic issues that require resolution for their conservation and management. Many new taxa are routinely uncovered during Biological Survey.

It aligns with Corporate Priorities 5 and 12, NC KRA 4 and NC 4C.

Aims

- To provide informative, stable taxonomy of potentially conservation dependent taxa to aid their conservation and management, especially rare flora. To ensure that new taxa discovered during Biological survey are curated and described where possible. Studies are being undertaken on the following:
    - *Adenanthos pungens*; Taxonomic status of 2 named subspecies.
    - *Calytrix breviseta*; status of hills population and taxonomic status of 2 named subspecies.
    - Native and naturalized species in *O. corniculata* complex.
    - *Hypocalymma angustifolum;* taxonomic status of Yerina Springs.
    - *Adenathos eyeri/A. forrestii/A. ileticos* species complex.
    - Taxonomy of *Cynoglossum* in Western Australia.
    - *Grevillea curviloba* and *Grevillea evanescens* taxonomy.
    - Publication of ms DRF *Darwinia* species.

Summary of progress and main findings

- Paper with M Lyons describing anew species of *Tribonanthes* published in Nuytsia.
- A paper describing the 6 DRF *Darwinia* species with phrase names is in press.
- A paper formally naming the rare subspecies of *Apium prostratum* is in press.
- A paper naming 2 highly restricted *Stylidium* species (with J Wedge and B Keighery) has been submitted.
- Paper describing new highly restricted *Lomandra* from the Whicher Range is in press.
- Paper describing New *Hypoxis* from Wheatbelt (with M Lyons) is in press.

Management implications

- *Grevillea evanescens* is not a species, it is not extinct and is more common than previously considered.
- Widespread weed *Oxalis corniculata* shown to be comprised of mainly native species

Future directions (next 12-18 months)

- Complete field work on *Adenanthos forrestii* complex.
- Taxonomic Notes on *Hypocalymma* in press.
- Taxonomic Notes on *Adenanthos pungens* in press.
- New Taxa of Conservation Concern in *Darwinia* published.
- Taxonomy notes on *Calytrix breviseta* prepared.
- Taxonomic notes on *Cynoglossum* prepared.

DEC Regions

South Coast, Midwest, Swan, Wheatbelt.

IBRA Regions

Geraldton Sandplains, Esperance Plains, Swan Coastal Plain, Avon Wheatbelt, Coolgardie, Mallee.

NRM Regions

Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

Wattles of the Pilbara

SPP # 2004/0022

Team members

B Maslin (0.1); S van Leeuwen (PSB component).

Context

Acacia is a key genus in the Pilbara dominating many of the ecosystems across the Region. Understanding their taxonomy and the ability to readily identify taxa in this Region is critical to facilitate their conservation and management.

Aligns with Corporate Priorities 5, 12, KRA 3, 4 and sub outputs NC 3C, NC 4C.

Aim

To produce a book and accompanying CD that will provide easy identification and access to relevant information for Pilbara Acacias in order to facilitate their management and use in nature conservation, rehabilitation and sustainable utilization .

Summary of progress and main findings

- Web page created in WorldWideWattle describing the Pilbara project

(http://www.worldwidewattle.com/infogallery/misc/pilbara.php).

- Field studies conducted to acquire relevant taxonomic information and photographs of species.
- Research conducted resulting in 10 new species and 2 new subspecies being recognized, and taxonomic problems in many other taxa resolved. Taxonomic paper prepared and submitted for publication.
- Draft distribution maps prepared based on Herbarium records and field observations.
- Draft descriptions prepared of most taxa summarizing relevant information on morphology, biology, ecology, distribution, utilization and conservation status.
- Available photograph assembled for publication in field guide (and now posted on the web).
- Bush Book manuscript in which 32 Pilbara taxa are described and illustrated has been submitted for publication.
- Preliminary electronic key to identification of Pilbara Wattles completed.

Management implications

- Identification and information dissemination of Pilbara *Acacia* species primarily to facilitate their management and conservation.

Future directions (next 12-18 months)

- Publish scientific findings and Bush Book (both currently in press).
- Complete and publish field guide to Pilbara Wattles: this will necessitate completion of line drawings of taxa, formatting existing text, assemble electronic key.

DEC Region
Pilbara.

IBRA Region
Pilbara.

NRM Region
Rangelands.

Conservation status and systematics of Western Australia Acacia

SPP # 2003/008

Team members
B Maslin (0.3), C Buscumb (1.0); Total (1.3).

Context
Acacia species are coming under increasing consideration for utilization as commercial crops for salinity control and re-vegetation programs, and for their importance in the management of remnant vegetation. Understanding their biology and taxonomy is important if their utilization is to be sustainable and their conservation effective.

Aligns with Corporate Priorities 5, 12, NC KRA 4 and sub outputs NC 4C, NC 3F.

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

- *Acacia saligna*: collaboration with CSIRO colleague established to progress taxonomic study; summary of *A. saligna* research posted on WorldWideWattle website; taxonomic revision of *A.*

saligna completed.

- Curation of Herbarium *Acacia* collections ongoing (as basis for re-assessment of conservation status of the WA taxa).
- A new species, *A. splendens* (with C Elliott), published.
- A number of taxonomic paper completed (some with C Buscumb) in which new species of *Acacia* are described (many from the banded ironstone formations of the arid zone).
- Formal proposal to conserve the name Acacia cyclops completed (with P Wilson) and submitted for publication.
- Field and herbarium study of *A. verniciflua* group undertaken in Victoria (with D Murphy); taxonomic review paper in progress.

Management implications

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

Future directions (next 12-18 months)

- Complete write-up of *A. microbotrya* project.
- Continue reassessment of conservation status of WA *Acacia* flora.
- Publish taxonomic descriptions of new W.A. species and review of *A. verniciflua* group.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan.

Wattles in the Shire of Dalwallinu
SPP # 2000/0013

Team member
B Maslin (0.1).

Context
The Dalwallinu Shire has one of the richest *Acacia* floras anywhere in the world. The improved identification of *Acacia* in this area combined with their promotion for conservation and land management is leading to increased local interest not only in *Acacia* conservation but biodiversity conservation in general.

Aligns with Corporate Priorities 5, 12, NC KRA 4 and sub outputs NC 4C, NC 3F.

Aim

- To research and promote *Acacias* of the Dalwallinu Shire.
- To publish a book (field guide) and scientific papers.
- To conduct an Acacia Symposium in Dalwallinu.
- To develop an Acacia website (called WorldWideWattle).
- To participating in the creation of an Environmental Interpretive Centre in Dalwallinu.

Summary of progress and main findings

- Developments to WorldWideWattle website undertaken resulting in increased functionality and

content.

Management implications

- Greater understanding of *Acacia* conservation.

Future directions (next 12-18 months)

- WorldWideWattle: maintain and further develop the website.
- Dalwallinu Environmental Interpretive Centre: continue to provide professional guidance as requested by the Shire of Dalwallinu.
- Progress field guide to *Acacias* of the Dalwallinu Shire.

DEC Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Region
Northern Agricultural.

Understanding Mulga

SPP # not yet allocated

Team members
B Maslin (0.5), R Fairman (1.0), J Reid (1.0); External collaborators (J Miller, Uni. Iowa; R Rutishauser, Uni Zurich); Total (2.5).

Context
Mulga forms a significant component of rangelands vegetation. These species are crucially important to the structure, ecology and functioning of these systems, as well as being of economic importance. Mulga species, especially *A. aneura* itself, are notoriously variable, the taxonomic boundaries are poorly understood and identification of these taxa is extremely difficult. Understanding this variation, determining its causal factors and being able to reliably identify the taxa, are critically important to the effective management, conservation and utilization of this valuable resource.

Aligns with Corporate Priorities Aligns with Corporate Priorities 5, 12, NC KRA 4 and sub outputs NC 4C, NC 3F.

Aim
To elucidate variation patterns within species of the Mulga group to provide a reliable means of identifying the taxa so that they may be effectively managed, conserved and sustainably utilized.

Summary of progress and main findings

- Field studies undertaken in Murchison district to collect material for taxonomic and genetic study, and seed for ontogenetic study.
- Microsatellite library constructed.
- Preliminary taxonomic sort of the herbarium collections undertaken.
- Draft content for web prepared (to be posted on WorldWideWattle website).

Management implications

- Clarification of the taxonomy of Mulga species will facilitate their effective conservation.

Future directions (next 12-18 months)

- Undertake further field work in areas of the State not yet surveyed to acquire additional material for taxonomic, genetic, anatomical and ontogenetic studies.
- Continue scrutiny of collections and to relate taxa thus recognized to groups defined by the genetic and other studies.
- Progress ontogenetic and anatomical study.

DEC Regions

Pilbara, Midwest, Goldfields.

IBRA Regions

Pilbara, Little Sandy Desert, Gibson Desert, Central Ranges, Great Victoria Desert, Yalgoo, Murchison, Nullarbor, Coolgardie, Gascoyne.

NRM Region

Rangelands.

Taxonomic review and conservation status of the members of the Myrtaceae tribe Chamelaucieae and miscellaneous other Western Australian plant groups

SPP # 1993/0011

Team members

B Rye (0.5), M Trudgen (0.5); Total (1.0).

Context

The main group of plants under study comprises over 400 species of shrubs in the Myrtaceae. They are very poorly known at both the species and generic levels. The lack of an adequate taxonomy continues to impede their conservation, study (in fields other than taxonomy) and commercial utilization. Other plant groups under study have also been chosen from amongst the Western Australian taxa most in need of taxonomic review.

Aligns with Corporate Priorities 5 and 12.

Aim

Publication of a series of taxonomic papers, including many new genera and species; continuous updating of the list of taxa requiring conservation priority; completion of a 'Flora of Australia' treatment of many members of tribe Chamelaucieae of the Myrtaceae and continued updating of an interactive key to members of this tribe.

Summary of progress and main findings

- Interactive key to members of the Myrtaceae tribe Chamelaucieae currently includes most Western Australian taxa and all taxa from other states of Australia.
- Since 2005, 7 papers have been published and 9 submitted.
- Draft flora treatments have been prepared for over 30 genera.
- Field studies have been conducted to most areas of the south-west, significantly increasing the specimens incorporated and the photographs available on FloraBase.
- Many changes to Priority Flora list.

Management implications

- Having an improved understanding of the numbers and status of the taxa and an interactive key to provide a practical means of identification of all species will facilitate their management and conservation.

Future directions (next 12-18 months)

- Continue improving the interactive key.
- Publish a special issue of Nuytsia on Myrtaceae tribe Chamelaucieae.
- Contact field studies on poorly collected and taxonomically difficult species groups.
- Prepare papers on *Isopogon* and *Petrophile*.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

Resolution and description of new plant species in the Yilgarn ironstone and Ravensthorpe Range areas subject to mining interest
SPP # not yet allocated

Team Members
R Butcher (1.0), K Shepherd (1.0), T Macfarlane (0.1), J Wege (1.0), C Wilkins (0.2); Total (3.3).

Context
Western Australia has a rich flora that is far from fully known. New species continue to be discovered through the taxonomic assessment of herbarium collections, floristic surveys and the botanical assessment of mineral leases. There are approximately 1 800 putatively new and undescribed taxa in Western Australia, a significant proportion (30%) of which are poorly known, geographically restricted and/or under threat (i.e. Declared Rare or Priority Flora). The lack of detailed information on these taxa makes accurate identification problematic and inevitably delays the Department's ability to survey and accurately assess their conservation status.

Aim
To resolve the taxonomy and expedite the description of manuscript or phrase-named plant taxa, particularly in areas where they may be vulnerable to future mining activities. There are 2 focus regions: the Banded Ironstone Formations of the Yilgarn, and the Ravensthorpe Range and Bandalup Hill. This project will also target unnamed Priority and Declared Rare Flora regardless of where they occur in Western Australia.

The species descriptions will be published in a Special Edition of the Herbarium journal *Nuytsia*.

Summary of Progress

- The Special Edition is in preparation and will contain *c*. 40 manuscripts, over half of which have been contributed by staff of the Western Australian Herbarium. It will include the formal description of over 80 new plant taxa, belonging to 20 plant families and 34 genera.
- Over 40 local or interstate botanists have been contacted in relation to the genera they have expertise in, resulting in *c*. 30 manuscript submissions to the Special Edition, 8 of which are in collaboration with a team member.
- 19 manuscripts have been completed by team members for the Special Edition.
- The taxonomic status of 33 taxa has been resolved by team members and descriptions generated for the Special Edition.
- Descriptions for an additional 9 taxa have been completed by team members for publication outside of the Special Edition.
- Descriptions for 11 named taxa have been revised by the team members for the Special Edition.

- Two putatively new taxa have been removed from the Western Australian Plant Census as a result of taxonomic assessment.
- Seven phrase names have been added to the Western Australian Plant Census as a result of taxonomic assessment.
- Team members have liaised with and assisted 20 local or interstate botanists in the preparation of their manuscripts.
- A further 5 taxonomic, systematic and/or nomenclatural papers produced by team members have been accepted for publication, or have been published, outside of the Special Edition. These comprise the description of 6 new taxa, the revision of 2 existing names, the conservation of 1 name, and the transfer of 30 species and 13 subspecies from 4 different genera into a single genus.

Management Implications

The availability of species descriptions and associated data will facilitate their identification by DEC personnel, botanical consultants, students and academics etc., enabling their conservation status to be more accurately assessed.

Future Directions (next 6 months)

- Edit *c.* 40 manuscripts and publish Special Edition of *Nuytsia*.
- Prioritize the taxa that require formal description over the next 1-2 years and plan a research program accordingly.
- Conduct field work to help resolve the taxonomy of the target species.
- Design collaborative taxonomic and systematic projects with universities to increase the awareness of plant biodiversity in Western Australia and engage undergraduate and postgraduate students in plant taxonomic research.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Taxonomy of undescribed conservation taxa in the epacrid genera *Leucopogon*, *Monotoca* and *Oligarrhena* (Ericaceae)

SPP # not yet allocated

Team members

A Chapman (0.2), M Hislop (0.1); Total (0.3).

Context

Epacrid classification is undergoing fundamental reassessment at the family and generic level as new information on relationships is revealed. However, much of the information on epacrid taxa currently available is accessed through the traditional classifications first developed by Robert Brown and then George Bentham. This project will elaborate modern concepts of species relationships and higher level groupings in the epacrids, publish new taxa in line with new generic concepts and work towards communicating the new classifications through the publication of detailed content in print, on FloraBase and using interactive keys to aid their identification.

This project aligns with Biodiversity Conservation Strategy and Science Division Strategic Plan goals to describe new taxa, necessary for an adequate understanding of plant biodiversity in WA.

Aims

- Revise generic concepts in line with recent systematic studies.
- Publication in *Nuytsia* of new taxa in these gener.
- Detailed description of a number of species in each genus.
- Publication of one or more interactive keys on FloraBase.

Summary of progress and main findings

- Research into the relationships of WA *Monotoca* and *Oligarrhena* based on morphological and molecular evidence progressed.
- Joint paper publishing 5 new species of *Leucopogon* accepted for publication in the journal *Nuytsia*.
- Paper describing a new species of *Monotoca* finalized for submission.
- Continued collaboration on generic concepts with specialists in other genera within the tribe *Styphelieae*, and involving the WA Herbarium, Edith Cowan University and Royal Botanic Gardens, Sydney.
- Standard character list for comparative morphological data capture across the family expanded and simplified in preparation for publication in FloraBase.
- Collection and re-determination of *Leucopogon* and *Monotoca* specimens in the WA Herbarium and other Australian collections, improving the standard of identification in the collection, and veracity of FloraBase output.

Management implications

- The epacrids, of which *Leucopogon* comprises by far the largest genus, have a major centre of diversity in south-west WA. With over 300 taxa (in 18 genera) of shrubs and small trees occurring largely on sandy, nutrient-poor, acid soils, their presence commonly defines heathland ecosystems. Over 90 are listed as conservation taxa. With the current flux in classification and taxonomy in a group found difficult to identify to species level, an authoritative source of current information is fundamental to correctly managing the conservation taxa and the lands on which they occur.
- As a group, the epacrids are very susceptible to a number of major threatening processes, including salinity and *Phytophthora* dieback. For example, in south-west Western Australia some 20 epacrids are considered common indicator species for the presence of dieback, and are second only to the Proteaceae in terms of listed species affected. It has been estimated that up to 80% of the epacrid flora of WA's South West Botanical Province are susceptible to dieback.

Future directions (next 12-18 months)

- Critically examine and score key morphological characters to prepare descriptions, keys – for 30 taxa.
- Submission and acceptance of a paper describing further species of *Leucopogon.*
- Submission of paper describing *Monotoca aristata* ms and its systematic placement.
- Publish 70 WA *Leucopogon* detailed descriptions in FloraBase.

DEC Regions

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

IBRA Regions

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

NRM Regions

Avon, Northern Agricultural, South Coast, Swan.

Taxonomy of selected families including legumes, grasses and lilies

SPP # not yet allocated

Team members

T Macfarlane (0.7), R Cranfield (0.4); Total (1.1).

Context

Successful conservation of the flora requires that the conservation units equate to properly defined, described and named taxa. The flora of Western Australia is far from completely known so taxonomic research and publication is needed.

Strategic context (in relation to Corporate Plan and Business Plan): Biodiversity Conservation Strategy draft, Summary point 6.

Aims

- To identify plant groups where there are taxonomic issues that need to be resolved, including apparently new species to be described and unsatisfactory taxonomy that requires clarification.
- To carry out research using fieldwork, herbarium collections and laboratory work.
- Publish results as journal articles and as contributions to FloraBase.
-

Summary of progress and main findings

- *Wurmbea* (Colchicaceae): field work in Gascoyne – Murchison studying presumed new species and species inadequately known, with data now adequate for description of several species. Drafted a paper on a new species from the Gascoyne region. Submitted a collaborative paper on phylogeny in relation to flower evolution with overseas colleagues.
- Hydatellaceae came to prominence as a primitive Flowering Plant in overseas work. Submitted 2 papers with overseas colleagues.
- *Austrodanthonia* (Poaceae): further fieldwork on a poorly known taxon in the wheatbelt.
- *Neurachne* (Poaceae): drafted a paper describing a new species from the Yilgarn.
- *Pentapogon quadrifidus*: submitted a paper substantiating the native status of this species which has only recently been discovered in WA.
- *Petrophile* (Proteaceae): prepared paper describing a new species from ironstone in the Yalgoo region (Cranfield & Macfarlane).
- Interactive key and descriptive database for WA genera and families of Flowering Plants for FloraBase content: completed the key (with Herbarium Databases and Publications staff).
- *Thysanotus*: commenced supervision of a research student studying the phylogeny of the genus.
- *Baeckea* group (Myrtaceae): continued in supervisory and coordination role for this collaborative project of B.L. Rye and M.E. Trudgen who are revising the taxonomy of this large group of small-flowered myrtle shrubs.
- Australian Plant Census: continued as departmental representative on the Working Group of the Council of Heads of Australasian Herbaria overseeing the checking by Herbarium curatorial staff of lists of taxon names for particular plant families. This is aimed at a standard national list of accepted plant species for Australia.
- Participated in the Warren Region Flora Recovery Team annual meeting and contributed expertise to Regional staff on flora conservation matters, especially for Frankland District.
- Weeds: participated in Manjimup Weed Action Group. Presented a talk on the Blackberry distributional survey to the National Blackberry Taskforce tour group at Manjimup.
- Quarram grasslands management team, Frankland District – provided botanical support, participated in field post-fire monitoring, attended Coastal fire Workshop, Walpole.
- Identification workshop: participated in giving a one-day plant identification workshop at Manjimup for departmental and community members sponsored by the Regional Herbarium project based in Bunbury.
- Taxonomic review of *Leptospermum spinescens* (Myrtaceae) as an investigation into a proposed new species in the Ravensthorpe Range. First draft of a paper prepared and field work to test the

findings planned.

- Paper drafted describing Atriplex sp. De Grey (Chenopodiaceae) as a new species.
- A revision of *Brachyloma* (Epacridaceae) which has been carried out over several years was completed and a paper drafted.

Future directions (next 12-18 months)

- Focus on assessing and formalizing the taxonomy of as many presumed new species as possible.
- Progress with ongoing taxonomic studies of various plant groups to improve knowledge of the flora.
- Contribute major new content to FloraBase, particularly interactive identification keys.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

Taxonomic studies in selected familes, including Astereaceae, Celastraceae Malvaceae, Proteaceae
SPP # not yet allocated

Team member
N Lander (0.9).

Context
Asteraceae classification is undergoing fundamental reassessment at the genus and species level. In Australia this is gaining momentum in preparation for the forthcoming publication of the Flora of Australia volumes dealing with this family. This project will resolve the limits of currently accepted species within the largest Australasian genus in this family, Olearia, formally describe and publish new taxa species, provide identification tools to distinguish between them. A number of new satellite genera will be described, and a review of the small related genus *Eriodiophyllum* will be presented. Additionally, it will provide an interactive identification key for all WA genera within the family for incorporation in FloraBase.

In connection with the Biodiversity Conservation Project (BCI) a number of putative new taxa in Asteraceae, Celastraceae and Malvaceae will be resolved and new species published if necessary. Also in this context, a series of interactive keys and information retrieval systems for genera in the family Proteaceae will be maintained, extended and prepared for incorporation in FloraBase.

This project aligns with Biodiversity Conservation Strategy and Science Division Strategic Plan goals to describe new taxa, necessary for an adequate understanding of plant biodiversity in WA.

Aims

- Revise genus Olearia in Australia.
- Resolve BCI species in Asteraceae, Celastraceae, Malvaceae.
- Publication in Nuytsia and other suitable journals of new taxa in the above groups.
- Publish review of genus *Erodiophyllum*.
- Publication of interactive keys in FloraBase to Asteraceae genera of WA, Olearia species of WA, Proteaceae species in WA in genera *Banksia*/*Dryandra*, *Conospermum*, *Grevillea*, *Hakea*.

Summary of progress and main findings

- Paper completed: Elucidation of *Olearia* species related to *O. paucidentata* (Asteraceae: Astereae).
- Paper completed: New species of *Olearia* (Astereaceae: Astereae) from Western Australia.
- Paper completed: Review of the genus *Erodiophyllum* (Asteraceae: Astereae).
- Interactive key to WA *Grevillea* Species prepared for publication in FloraBase. Currently being ported to Lucid.

Management implications

- The Asteraceae have a major centre of diversity in WA, with over 560 species (in 181 genera) of shrubs and herbs occurring in virtually every environment. Over 80 are listed as conservation taxa. With the current flux in classification and taxonomy in a group found difficult to identify to species level, an authoritative source of current information is fundamental to correctly managing the conservation taxa and the lands on which they occur. Additionally, the Astereaceae are represented in WA by 125 weedy species, some of critical significance.
- As a group, the Proteaceae are highly susceptible to a number of major threatening processes, including salinity and *Phytophthora* dieback. For example, in south west Western Australia some members of this family are common indicator species for the presence of dieback, and are second the family with the highest number of listed species affected. It has been estimated that up to 80% of the epacrid flora of WA's South West Botanical Province are susceptible to dieback.

Future directions (next 12-18 months)

- Prepare papers on taxonomy of Olearia and several new genera.
- Complete interactive key to WA Asteraceae Genera for incorporation in FloraBase.
- Complete interactive key Olearia for incorporation in FloraBase.
- Resolve BCI taxa in *Eclipta*, *Flaveria*, *Wedelia*, *Lawrencia*, *Maytenus* and publish new taxa as necessary.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Herbarium collections management

Core Function

Team members

K Knight (1.0), K Thiele (1.0), R Cranfield (0.4), R Rees (1.0), C Parker (0.2), P Spencer (0.5),M Falconer (0.6), BS Mahon (0.2), R Davis (0.8) S Arkeveld (1.0), A Chapman (0.1), M Hislop (0.9); Total (7.8).

Context

The Western Australian Herbarium's collections provide the core resource for knowledge of the State's flora and fungi. The collection is growing constantly, through addition of new specimens representing new taxa and new records of existing taxa. The collection is maintained to a high standard, and provides DEC and the community with the fundamental resource to allow accurate identification of plant and fungi specimens throughout Western Australia.

Aims

- To fully document and audit the diversity of Western Australia's plants, algae and fungi.
- To maintain in perpetuity a comprehensive, adequate and representative research and archive collection of specimens of all taxa in these groups occurring in Western Australia.
- To contribute to, support and service the research, conservation and decision-making activities of DEC.
- To contribute to, support and service taxonomic research by the world's scientific community.

Summary of progress

- 26 726 specimens were added to the collection, which now stands at 670 344, a 4.6% increase during the year.
- The major plant groups now in the collection are as follows:

Taxonomic Group	**Number of specimens (June 2007)**	**Increase since June 2006**	
		Number	%
Myxomycetes	567	90	18.8
Fungi	22 117	11 412	106
Lichens	14 253	1 841	14.8
Algae	21 284	620	3.0
Liverwort & Hornworts	1 829	-1	0
Mosses	6 293	-295	-4.5
Ferns and fern allies	3 355	100	3.1
Gymnosperms	1 902	28	1.5
Flowering Plants	598 744	12 931	2.2
Total number	670 344	26 726	4.6

Curation

- Significant curatorial work was accomplished in the genera *Eucalyptus*, *Bossiaea*, *Leucopogon*, *Lepidosperma*, *Eremophila*, *Goodenia*, *Acacia*, *Chrysocephalum*, *Stylidium*, *Thryptomene Micromyrtus*, and orchids, and in the lichens.
- Declared Rare Flora taxa curated, see under WACensus and WAHerb.
- Significant collections added to the Herbarium holdings were as follows:
    - Yilgarn Ranges Survey.
    - Salinity Action Plan Survey.
    - Woodland Watch.
    - Wetland Watch.
    - Pilbara Regional Herbarium.
    - J Chappill University of Western Australia collections.
    - Threatened Flora Seed Centre vouchers.
    - Kings Park.
    - DEC Regional Offices and Regional Herbaria.
- Loans and exchange
    - Loans outward – 2 335 specimens.
    - Loans inward - 787 specimens.
    - Exchange outward – 3 246 specimens.
    - Exchange inward - 801 specimens (including CD images from Kew and lichens).
- Managed and supported by the curatorial staff, volunteer participation again was significant, totaling 10,471 hours (equivalent to 5.8 full-time positions).
- Tasks Managed by curation staff with the assistance of volunteers were as follows:
    - Mounting 10 000 specimens.
    - General curation of specimens.
    - Assisting in the incorporation of specimens into the collection.

    - Maintaining and adding specimens to the Reference Herbarium collection.
    - Validating doubtful location outliers.
- Specialist Volunteer Projects:
    - Continuing the validation of the 6,000 specimens of the W.E. Blackall collection.
    - Curating *Austrostipa*, *Eucalyptus*, *Pterostylis*, *Verticordia* and *Calandrinia.*
    - Capturing and preparing composite images for FloraBase (see below).
    - Increasing the collection and documentation of Myxomycetes
    - Completing a key to the species of *Grevillea* in Western Australia, and continuing with keys to other genera of Proteaceae including the difficult genus *Synaphea*.

Reference Herbarium

- Maintained and increased the number of taxa represented in the Reference Herbarium. The Reference Herbarium currently has 13 993 specimens representing c. 11 000 taxa.
- Over 3 000 visitors used this resource to identify plant specimens during the year.

Future directions (next 12-18 months)

- The move to the new Biodiversity Science Centre will provide a challenge to the Herbarium over the next 12-18 months. During this time the collection will be prepared for the move, to ensure a smooth transition with a minimum of disruption.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

The Western Australian plant census and Australian plant census

Core Function

Team Members

S Carroll (0.4); C. Parker (0.1); T. Macfarlane (0.1); Total (0.6).

Context

The Western Australian Plant Census (WACensus) is a complete, authoritative database of all names of plants in Western Australia, including synonyms created by taxonomic change. It is continually updated to reflect changes in our knowledge of the flora. The Census constitutes the fundamental master list for many DEC processes and datasets, including the Declared Rare and Priority Flora databases maintained by the Species and Communities Branch, the Herbarium's specimen database, the MAX database utility and NatureMap.

The Australian Plant Census is a project of the Council of Heads of Australian Herbaria, designed to provide a consensus view of all Australian plant taxa. The APC has dealt with approximately half of the plant names in Australia. The Western Australian Herbarium is providing substantial input into the APC project through an APC Working Group. As the APC project continues, the Western Australian Plant Census is updated to reflect the consensus view.

Aims

- To maintain an accurate and up-to-date listing of all plants and fungi in Western Australia, including both current names and synonyms.

Summary of progress

- A total of 492 new names were added to WACensus, with 190 being new manuscript or phrase names and 302 being published names.
- A total of 354 edits (corrections, updates etc) were made to WACensus.
- WACensus updates are regularly distributed to over 383 registered Max users on a monthly basis.

Management implications

- All DEC systems utilizing WA plant names are 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 directions (next 12-18 months)

- The Census currently includes names of all vascular plants, lichens and algae. Work during 2007-08 will add mosses, liverworts and a draft list of fungi to the Census.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

The WA Herbarium's specimen database

Core Function

Team Members

S Carroll (0.6), M Falconer (0.4), K Veryard (0.6), E McGough (0.5), L Biggs (0.6); Total (2.7).

Context

The Western Australian Herbarium's specimen database allows staff at the Herbarium to manage and maintain the Herbarium's collections, and provides core data on the distribution, ecology and morphology of all taxa for DEC and the community, through the FloraBase and NatureMap websites. Data from the specimen database is provided to researchers, consultants and community members on request.

Aim

To capture, maintain and validate spatial, phenological, population & habitat data for all the Herbarium's collections, enabling curation of the collection and providing core data for FloraBase and DEC decision support and research.

Summary of progress

- 16 951 records were added during 2006-07.
- Records for 1 322 Priority Flora and 244 Declared Rare Flora were added to the database.
- 61 requests for specimen data (species lists for areas of WA, specimen label data for particular taxa) were processed from DEC offices, researchers and the general public.

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 directions (next 12-18 months)

- 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.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

NUYTSIA – Western Australia's Journal of Systematic Botany

Core Function

Team Members
A Chapman (0.2), BS Mahon (0.2), M Falconer (0.2); Total (0.6).

Context
NUYTSIA has been the primary means of communicating new taxonomic concepts and ecological information on the Western Australian flora since 1970. Specialists from around Australia and within DEC regularly contribute taxonomic and systematics papers to the journal.

Aim
To maintain a professional house journal for publication of taxonomic papers relevant to the Western Australian flora.

Achievements

- Publication of volume 16-1, containing 23 papers and short communications, with the formal recognition of 52 new taxa in 14 plant families, including 25 conservation taxa, 2 lichen species and a new fungus – completed.
- Migration of the publication template to Adobe InDesign - completed.
- Preparation of 1 or 2 further parts for publication, containing *c.* 40 papers and short communications, prioritizing the work of new taxonomists at the WA Herbarium as part of DEC's Save Our Species initiative – commenced.
- Maintenance of the online presence for the journal including current contents, abstracts and download of recent papers. Other resources include a search tool across all papers and short communications, standard mapping templates and a Latin plant name dictionary - ongoing.

Management implications

- Management of the State's biodiversity must be based on sound scientific principles and evidence. *Nuytsia* provides the primary means for establishing new WA plant taxa in the scientific literature and revising taxonomic concepts in line with the latest science.

Future directions (next 12-18 months)

- Publish 2 parts, containing 29 papers and short communications, with the formal recognition of *c.* 50 new taxa.
- Develop a modern design for volume 17, as an adjunct to the renewed focus on taxonomy and the Herbarium.

- Integrate science with curation processes to ensure a better-quality and more scientifically rigorous publication. Also provides a more efficient incorporation of newly published names into Herbarium information systems and so to the public via FloraBase.
- Integration of published protologues and papers directly into FloraBase (as part of SOS FloraBase project).

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

FloraBase – the Western Australian flora
Core Function

Team Members
A Chapman (0.5), B Richardson (0.6), A Spooner (0.3), T Macfarlane (0.1), N Lander (0.1); Total (1.6).

Context
FloraBase, the web information system for the Western Australian flora, has increasingly become DEC's main means of communicating botanical taxonomic information. Based on 3 constantly maintained corporate datasets, FloraBase is developing to become a model global information resource. FloraBase delivers its data using international data standards, an important issue in an increasingly connected world. Regular updates provide improved access and new features to the site. FloraBase draws on the efforts of staff and volunteers from all Divisional Programs.

Aim
To deliver authoritative taxon-level and specimen-level information on all Western Australian plants and fungi to a wide audience, using efficient, effective and rigorous web-based technologies.

Summary of progress
Design and system
- Development of a 5-year plan for new features and additional funding – commenced.
- Implementation of BioCASe and LSID providers to support alternative methods for serving data (e.g. to the Australian Virtual Herbarium and Global Biodiversity Information Facility) - ongoing.
- Implementation of a staged roll-out of features and improvements documented in the Herbarium's issues tracking project (MANTIS) - ongoing.
- Management of volunteers in image and description teams - ongoing.
- System analysis and review of short description capture and delivery processes - completed.
- Development of infrastructure and methods for adding interactive keys - stage one completed.
- Addition of infrastructure to support the presentation of cryptogamic elements of the flora - stage one completed.
- Installation of a new production server and increased storage capacity - completed.

Botanical content
- Addition of interactive keys for the WA genera and families, part-funded by the Save Our Species (SOS) project. –stage one completed.
- Integration of available PDF's of *Nuytsia* journal protologues more tightly into FloraBase, part-funded by the SOS project – stage one completed.
- Addition of new mapping templates and bioregional query functionality – commenced.

- Maintenance of generic and family descriptions – ongoing.
- Maintenance of standard descriptive data for new and revised species - ongoing.
- Maintenance of flora statistics page, publishing summary data on numbers of WA flora - ongoing.
- Maintenance of a phylogenetic tool for exploring higher-level systematics of WA Flora - ongoing.
- Maintenance of standard elements such as taxon maps, composite images and help pages - ongoing.

Technology transfer and promotion

- Training workshops to community conservation groups, DEC staff and the education sector – as required.
- Collaboration with DEC's Eco-Education unit, including STAWA training workshops and the regular provision of Plant of the Month content for their Statewide Newsletter.

Management implications

- FloraBase continues to provide access to authoritative and accurate information on the State's flora. The community and conservation staff are able to retrieve the most recent information on the name, features, status and distribution of the 13 089 currently recognized native and naturalized WA vascular plant taxa. Consequently, conservation efforts across the State are made more effective by building on quality current 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. Collaboration with external agencies and community groups wanting to maximize their conservation efforts is beginning to deliver qualitative improvements in the persistent documentation of flora surveys in the conservation estate.

Future directions (next 12-18 months)

- Add new content, including interactive keys for identification of several plant groups.
- Add further standards support to allow FloraBase to participate in national and international bio-infrastructure projects.
- Add of further necessary infrastructure to support the presentation of cryptogamic elements of the flora.
- Plan for the expansion of content for other groups, especially the algae, lichens and fungi of WA, when funding becomes available.
- Maintain the quality of information and the adequacy of software and hardware systems.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Taxonomic review and floristic studies of the benthic marine algae of north-western Western Australian and floristic surveys of Western Australian marine benthic algae

SPP # not yet allocated

Team members

J Huisman (0.8); C Parker (0.1); Total (0.9).

Context

This project involves systematic research into a poorly known group of Western Australian plants and is directly relevant to the Department's nature conservation strategy. It includes floristic studies of the marine plants of several existing/proposed marine parks and also areas of commercial interest (Ningaloo, Dampier Archipelago, Barrow Island, Montebello Islands, Rowley Shoals, Scott Reef, Maret Islands etc.). In addition, the general floristic surveys will provide baseline information enabling a more comprehensive assessment of the Western Australian marine biodiversity.

It aligns with Corporate Priorities KRA 1; KRA 2; KRA 3; KRA 4; KRA 6.

Aims

- To collect, curate and establish a collection of marine plants representative of the Western Australian marine flora, supplementing the existing WA Herbarium collection.
- To assess the biodiversity of the marine flora of Western Australia, concentrating initially on the poorly known flora of the tropics.
- To prepare a Flora for north-western Australia, documenting this biodiversity.

Summary of progress and main findings

- Funding has been received from various sources for this project (ABRS, WA Dept of Commerce & Trade) over previous years and completion of the 'Flora of North-western Australia is expected by mid 2008, at which time a manuscript will be provided to ABRS for publication in the 'Algae of Australia' series. Some 400 species will be included, for which most descriptions are now completed and illustrations are in preparation. Several publications dealing with aspects of this project have been published or are in press (see below). Portions of the Flora are being completed with various co-authors (Halymeniaceae with O De Clerck, Ghent University, Belgium; various Chlorophyta with F Leliaert and H Verbruggen, also Ghent University; Dictyotales with J Phillips, University of Queensland; Corallinaceae with R Cowan, Murdoch University).
- Paper in press (Cryptogamie, Algologie) describing the phylogenetic relationships of the poorly known green alga *Boodlea vanbosseae*
- Paper in preparation (Western Australian Museum) providing an annotated list of the marine plants of Mermaid Reef in the Rowley Shoals, Scott Reef and Seringapatam Reef.
- Article in Landscope (Winter 2007) describing the results of an expedition to the north-west atolls.

Future directions (next 12-18 months)

- Publication of papers describing new and existing genera, species and other categories; contributions to 'FloraBase'; finalize production of an 'Algae of Australia' Flora covering the marine plants of north-western Australia.

Management implications

- Enhanced knowledge of marine biodiversity allowing a more accurate assessment of management proposals.

DEC Regions

Kimberley, Pilbara, South Coast, South West, Swan, Warren.

IBRA Regions

Central Kimberley, Dampierland, Northern Kimberley, Victoria Bonaparte, Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Warren, Esperance Plains.

NRM Regions

Rangelands, Northern Agricultural, Swan, South West, South Coast.

The Western Australian marine benthic algae online and an interactive key to the genera of Australian marine benthic algae

SPP # not yet allocated

Team members

J Huisman (0.2), C Parker (0.2); Total (0.4).

Context

This project is a direct successor to the 'WA Marine Plants Online' (a core function). It will provide descriptions of the entire WA marine flora as presently known (some 1 000 species), accessible through FloraBase. In addition, an interactive key to the genera is in preparation that will enable positive identification of specimens and provide a baseline marine Flora for future revisions. This project will provide a user friendly resource that will enable the identification of marine plants by non-experts. It will be of great value in systematic research, teaching, environmental and ecological research, and additionally in environmental monitoring and quarantine procedures.

This project is presently externally funded from ABRS grants (partially through Murdoch University and partially through DEC - $40 700 for 2007/08, with indicative funding for 08/09 and 09/10).

It aligns with Corporate Priorities KRA 1; KRA 2; KRA 3; KRA 4; KRA 6.

Aims

- To prepare an interactive key to the 600 genera of Australian marine macroalgae, using the software LUCID.
- To provide online descriptions of the Western Australian marine flora as presently known (approximately 1 000 species).

Summary of progress and main findings

- Generic descriptions and photographs to be used in the key are being collated.
- Online species description component yet to begin.

Future directions (next 12-18 months)

- Complete generic descriptions and coding of LUCID key.
- Collate existing species descriptions (where available) and write new descriptions for uploading to FloraBase.

Management implications

- Enabling easier identification of marine plant species, leading to a more accurate understanding of their conservation status.
- Enhanced knowledge of marine biodiversity allowing a more accurate assessment of management proposals/ practices.
- Provide a readily available web-based information system will facilitate easy access by managers, researchers, community and other marine stakeholders to marine plant species inventories and up-to-date names.

DEC Regions

Kimberley, Pilbara, South Coast, South West, Swan, Warren.

IBRA Regions

Central Kimberley, Dampierland, Northern Kimberley, Victoria Bonaparte, Geraldton Sandplains, Swan Coastal Plain, Jarrah Forest, Warren, Esperance Plains.

NRM Regions

Rangelands, Northern Agricultural, Swan, South West, South Coast.

Perth Urban Bushland Fungi Project

Core function

Team member

N Bougher (0.4), R Hart (0.6), S DeBueger (0.4); Total (1.4).

Context

Knowledge of the fungi and other cryptic organisms that help keep the region's plants healthy is essential for effective conservation management of Perth's bushlands. This project has developed protocols to foster community participation and education while simultaneously capturing scientific data about fungi. PUBF is raising the previously low level of awareness and knowledge about fungi and encouraging the inclusion of fungi in bushland management.

This is a collaborative project between the Western Australian Naturalists' Club, the Perth Urban Bushland Council, and in conjunction with the Western Australian Herbarium.

This project is externally funded (LotteryWest).

Aims

- To promote a better understanding of the significance of fungal diversity and function in bushlands.
- To generate and provide access to scientifically accurate information about fungi of the Perth Region.

Summary of progress and main findings

- Conducted 86 workshops and forays in 38 urban bushlands.
- Produced foundation fungi inventories for 24 bushlands.
- Recorded 2928 fungi.
- Processed and vouchered over 400 fungi specimens for WA Herbarium collection.
- Published: popular press -e.g. feature article in Landscope; scientific journals e.g. – the genus Campanella in WA including a species new to Science from urban bushland, – the identity and ecology of weed fungus in urban bushlands.
- Provided fungi reports to 6 community group bushlands and to 3 regional parks, and made these available online .
- Commenced data management and physical process to integrate CSIRO fungal collection comprising ca 11 000 specimens into the WA Herbarium.
- Updated PUBF website at www.fungiperth.org.au.
- Produced a new and expanded edition of the online fungi field book for the Perth Region.

Management implications

- Perth's urban bushlands lie within one of the world's 34 terrestrial biodiversity hotspots for conservation priority, the only such hotspot in Australia.
- The bushlands are an important natural refuge for many fungi. Fungi underpin the long-term health and resilience of the bushlands.
- Knowledge of the fungi and other organisms that help keep the region's plants healthy is essential for effective conservation management of this hotspot region.

Future directions (next 12-18 months)

- Conduct 5 public field events (forays and workshops) and 4 contracted surveys during the 2007

season.

- Translate protocols developed by PUBF to regions beyond the coastal plain of Perth.
- Further the incorporation of PUBF and ex CSIRO fungal specimen data and species images into WA Herbarium databases.
- Incorporate PUBF fungi reports into DEC (former DoE) Reference site data files.
- Input PUBF data into the updated census of Western Australia's larger fungi.
- Input PUBF data into FloraBase or similar taxa-based online information system.

DEC Region
Swan.

IBRA Region
Swan Coastal Plain.

NRM Region
Swan.

Improving the comprehensiveness, accuracy and availability of taxonomic data about WA's fungi in DEC biological datasets and biodiversity collections
SPP # not yet allocated

Team member
N Bougher (0.6).

Context
This concept plan represents a new and timely effort to build the State's biodiversity knowledge base, and create and apply more comprehensive and accurate fungal scientific knowledge for conservation and management of the State's biodiversity.

Principles:

- Many times more Fungi than Plants in WA: *est*. 140 000 + fungi versus 14 000 vascular plants.
- Fungi are relevant and applicable for conservation & management of WA's biodiversity: Fungi perform vital ecological processes linking to plants and animals and influencing bushland health and restoration.
- Fungi are under-represented in DEC biological datasets, and in the State's biodiversity collections, and in information systems such as *FloraBase*.
- Awareness and application of fungi has been hindered by poor knowledge base, e.g. *est*. only 5-10% fungi documented; 2 600 out of est. 140 000. The ability of DEC and community to undertake systematic surveys of the State's biodiversity has been limited by low capacity to survey fungi.
- Demand for fungal expertise and information is increasing with increasing awareness of the role of fungi in ecosystems and the need for 'Flora, Fauna and Fungi' in conservation and management of the State's biodiversity. This includes the requirement for a better basis for assessment of the conservation status of fungi taxa.

Aims

- To generate and provide scientifically accurate and comprehensive taxonomic data for fungal taxa in WA previously unrecorded, unidentified, mis-identified, or ill-defined – particularly taxa of particular relevance to specific current DEC conservation initiatives.
- To make available descriptive information about fungi taxa in published form and in online information systems.
- To improve access and uptake of fungi scientific knowledge about fungi and thereby promote better awareness and understanding by scientists and community of the significance of fungal

diversity and function in bushlands.

- To achieve greater taxonomic and geographic representation of WA fungi in datasets and as permanent vouchers at the WA Herbarium.

Summary of progress and main findings

- Concept plan submitted.

Management implications

- The availability of scientifically accurate and comprehensive information about more taxa of fungi in WA will encourage and enable a greater uptake and capacity by DEC and community to incorporate fungi in management. This includes biological surveys, managing the interdependent linkages between fungi and plants and animals, and a better basis for assessment of the conservation status of fungi taxa.

Future directions (next 12-18 months)

- Generate and provide descriptive and identification data for fungal taxa involved in current DEC conservation initiatives.
- Foster community participation, education, and capacity to capture scientific data about fungi.
- Begin updated census of WA macrofungi.
- Begin input of descriptive fungi data into FloraBase or similar taxa-based online information system.
- Re-assess the conservation status of some fungi taxa in WA.

DEC Region

All.

IBRA Region

All.

NRM Region

All.

LANDSCAPE CONSERVATION

Program Leader: Dr Lachlan McCaw

FORESTCHECK – Integrated site-based monitoring of the effects of timber harvesting and silviculture in the jarrah forest

SPP #2006/003

Team members

R Robinson (0.2), L McCaw (0.2), J Farr (0.2), K Whitford (0.2), R Cranfield (0.2), A Mellican (0.2), G Liddelow (0.2), R Smith (0.2), V Tunsell (0.2), B Ward (0.2), A Wills (0.2), P Van Heurck (0.2); Total (2.2).

Context

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

FORESTCHECK aligns with Corporate Priorities 9 and 12, and KRA 2.2, 3.8 and 4.3.

Aim

- To quantify the effects of current timber harvesting and silvicultural practices in the jarrah forest (gap creation, shelterwood, post-harvest burning) on soils, macrofungi, cryptogams (lichens, liverworts and mosses), vascular plants, invertebrates, terrestrial vertebrates and birds.

Summary of progress and main findings

- Forty-eight monitoring grids have been established at 5 locations (Blackwood Plateau, Donnelly, Perth Hills, Wellington, Wellington East) throughout the jarrah forest.
- Stand structure (basal area and stocking of overstorey species) was measured at all sites.
- Sampling of soils compaction, cryptogams (lichens, liverworts and mosses), macrofungi, vascular plants, invertebrates, terrestrial vertebrates and birds have been completed for all grids.
- Data are undergoing analysis for publication in a series of papers detailing major findings and management implications.
- Annual progress reports for FORESTCHECK are available on the Science Division page of the DEC Web at: http://www.DEC.wa.gov.au/science/science.html.

Management implications

- FORESTCHECK provides a systematic framework for evaluating the effects of current silvicultural practices across a range of forest types and provides a sound basis for adaptive management.

Future directions (next 12-18 months)

- Major analysis of data for the first 5 yrs of monitoring is currently in progress.
- Report on 5 year results in 2008.
- Detailed results published in 2008.

DEC Regions

Warren, South West, Swan.

IBRA Regions
Jarrah Forest, Warren.

NRM Regions
South West, Swan.

Long-term effects of various fire regimes on species richness and composition of southern jarrah forest understorey

SPP # 93/099

Team members
N Burrows (0.05), B Ward (0.25), R Cranfield (0.05), G Liddelow (0.1); Total (0.45).

Context
Understanding long-term effects of fire on the floristics and structure of jarrah forests is important for developing and implementing ecologically appropriate fire regimes and for managing fire for the protection of life and property. This study, established in 1972, was designed as a long-term experiment.

It aligns with Corporate Priority 10, KRA 2 and 3 and sub-output NC 3K.

Aims
- To understand and quantify the long-term effects of different fire regimes on species richness, composition and structure of southern jarrah forest understorey.
- To determine the effects of different fire regimes on tree health and growth rate.

Summary of progress and main findings
- Spring and autumn burn treatments were applied at the Perup and McCorkhill sites. As reported previously, the Lindsay (Boundary Rd) experimental site has been abandoned because of infection by *Phytophthora*.
- Tree growth rates were re-measured at the Perup site to compare tree diameter growth rates over 20 years and across different fire treatments. The fire treatments, including frequent burning and fire exclusion, had no significant effect on tree diameter growth, which was mostly influenced by tree dominance status and size.

Management implications
- Regular prescribed burning is unlikely to have any adverse impacts on tree diameter growth.

Future directions (next 12-18 months)
- Maintain fire treatments.
- Gather soil samples for nutrient analysis, publish tree growth findings.
- Re-measure floristics on all plots (except Lindsay forest) in spring 2007.
- Preliminary analysis of data in summer 2007/08 and review future of study.

DEC Regions
South West, Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

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).

Context
There is concern that altered fire regimes in Kimberley savanna woodlands may be adversely impacting on the structure and recruitment of boabs, a Kimberley icon species.

This project aligns with KRA 3 (NC 3K).

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

- Survey data have been partially analyzed. Preliminary analysis shows that boabs display high resilience to fire. However, on some sites that have a history of frequent late dry season fires, there is a lack of recruitment due to fire damage to tree crowns and reproductive structures (flowers, buds and fruits).

Management implications

- Given the longevity of boab plants, their resilience to fire and the likelihood of some recruitment over time, altered fire regimes (high intensity late dry season fires) are unlikely to be a significant problem for the density and distribution of boabs in the longer term.

Future directions (next 12-18 months)

- This project has been assigned a low priority and has been terminated so that resources can be re-focused on higher priority issues. A progress report will be prepared.

DEC Region
Kimberley.

IBRA Region
Central Kimberley.

NRM Region
Rangelands.

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 (0.1), 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).

Context

Despite the relatively pristine nature of most of the arid interior (desert bioregions) and rangelands (beyond the pastoral zone), there has been an alarming and recent loss of mammal fauna with about 90% of medium-size mammals and 33% of all mammals either becoming extinct or suffering massive range contractions. There is also evidence of degradation of some floristic communities due to altered fires regimes. The extent and nature of change in other components of the biodiversity, including extant mammals, birds, reptiles and invertebrates is unknown. The most likely causes of the decline and degradation in biodiversity are introduced predators, especially the fox (*Vulpes vulpes*) and the feral cat (*Felis catus),* and altered fire regimes since the departure from traditional Aboriginal burning practices over much of the region. Taking an adaptive experimental management approach in partnership with Goldfields Region, this project will aim to reconstruct some assemblages of the original native mammal fauna on Lorna Glen, a pastoral lease recently acquired by DEC. This to be achieved by an integrated approach to controlling introduced predators and herbivores, ecologically appropriate fire management and fauna translocations.

This project aligns with 2005/06 Corporate priorities 3 and 12 and KRA 2 (NC 2A, NC 2B), KRA 3 (NC 3K), KRA 4, (NC 4A, NC 4B).

Aims

- 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 translocations 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

- Following successful feral cat baiting operations in 2004 and 2005, a follow-up operation was carried out in winter 2006, as part of the Western Shield program. Baiting successfully reduced the feral cat density by about 80-85%. Foxes were essentially eradicated and the wild dog/dingo population was significantly reduced with only a few animals recorded. Re-invasion by feral cats into the core area of the baited zone has been slow with very low cat densities recorded almost 12 months after baiting.
- Fire ecology (plants) and invertebrate monitoring sites were re-assessed. Data are being analyzed.
- The requirement for ongoing monitoring has been determined and potential new sites located.
- A model that enables vegetation cover to be determined from satellite imagery was developed, tested and shown to be reliable. A paper was published on this work.
- Translocation plans have been prepared for 2 species – bilby and brushtail Possum.
- Camel survey and aerial cull was conducted over the area.
- Fire management plan prepared and some strategic buffer and research burning was successfully carried.

Management implications

- Guidelines for the proactive management of fire in the arid zone to reduce the severity (scale and intensity) of wildfires and to provide habitat choice through mosaic burning.
- Guidelines for controlling introduced predators in the arid zone will be produced over the next 12 months. This project should also lead to the reconstruction and protection of arid zone mammals and other elements of the biota.

Future directions (next 12-18 months)

- Implement and assess the effectiveness of a fourth annual feral cat baiting program in July 2006.
- Continue to monitor extant fauna and vegetation.
- Continue assessments of fire plant ecology sites.
- Complete analysis and write-up of first stage of fire ecology (plants) study.
- Write-up and publish results of baiting trials at Lorna Glen.
- Prepare a translocation plan, and if baiting is successful, implement the plan in August 2007.
- Continue assessment of vascular plants and invertebrates.
- Continue to support a PhD study on the effects of fire on arid zone spiders.
- Encourage research partnerships to further knowledge of arid zone ecology.

DEC Region
Goldfields.

IBRA Regions
Murchison, Gascoyne.

NRM Region
Rangelands.

Walpole fine grain mosaic burning trial

SPP # 2004/004

Team members
N Burrows (0.1), J Farr (0.1), R Robinson (0.1), G Liddelow (0.1), B Ward (0.25), R Cranfield (0.05), P Van Heurck (0.1); Total (0.75). Frankland District are partners in the project and provide operational support for burning and ecological assessments.

Context
Fire management based on sound science is fundamental to the conservation of biodiversity and the protection of life and property in fire-maintained ecosystems of south-west WA. There is a substantial body of scientific evidence that, within ecologically circumscribed parameters, fire diversity can benefit biodiversity at the landscape scale. We hypothesize that a fine-grained mosaic of patches of vegetation representing a range of biologically-derived fire frequencies, seasons and intensities will provide diverse habitat opportunities and can also contribute to reducing the occurrence of large, damaging and homogenizing wildfires.

This study aligns with Corporate Priority 10, KRA 2.2 and 3.8 and sub-output NC 3K.

Aims

- To use the frequent and planned introduction of fire into the landscape (patch-burning) to create a fine-grained mosaic of interlocking patches of vegetation at different stages of post-fire development.
- To monitor at both the patch scale and the landscape scale, the effects of the resultant mosaic on biodiversity; specifically:
- Abundance of fire regime specific plant taxa, DRF and reserve listed taxa (e.g. *Synaphaea* sp., *Lambertia rariflora* subsp. *lutea*, *Banksia quercifolia*, *B. occidentalis*, *Dryandra formosa*, *Hakea oliefolia*).
- Geophytes (Orchidaceae, Droseraceae especially).
- Abundance of fire regime specific fauna and condition of associated habitats (e.g. honey possum (*Tarsipes rostratus*), quokka (*Setonix brachyurus*), mardo (*Antechinus flavipes*), sunset frog (*Spicospina flammocaerulea*)).

- Reptile assemblages.
- Bird assemblages.
- Invertebrate assemblages.
- Vascular plant assemblages.
- Fungi and cryptogams.

Summary of progress and main findings

- Ground assessment of aerial patch-burning was carried out to validate the satellite mapping of burn severity. The ground validation demonstrated that satellite mapping was accurate on larger burnt patches (> 0.5 ha, or narrow strips > 20-30 m wide) but was not always able to detect small burnt patches or unburnt patches within burnt patches.
- An invertebrate survey was conducted for spring 2006 and autumn 2007. Sample sorting is in progress.

Management implications

- The study demonstrates that fine grain patch-burning is operationally feasible in forest areas. The benefits to biodiversity are yet to be determined.

Future directions (next 12-18 months)

- Further/ongoing analysis of satellite imagery to determine patch-burn mosaic and distribution of seral stages.
- Ongoing mapping of seral stages.
- Re-assess monitoring grids in spring/autumn 2007.
- Patch-burning is scheduled for spring 2008.

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

Genetic analysis for the development of vegetation services and sustainable environmental management

SPP # 98/007

Team members
M Byrne (0.2), B Macdonald (0.5); Total (0.7).

Context
Understanding the genetic structure and function of plants is important for their effective utilization for revegetation and provision of ecosystem services, such as hydrological balance, pollination and habitat connectivity.

It aligns with KRA 3.7, 3.8 and 3.11 and Nature Conservation Priority 3G.

Aim
To provide genetic information for the conservation and utilization of revegetation species. Current work aims to identify the mating system and reproductive biology of *Acacia saligna*; determine pollen dispersal in DRJ clonal orchard of *Eucalyptus marginata*; investigate the mating system and diversity

in sandalwood, and determine genetic relationships between trees in a salinity/waterlogging trial in *E. occidentalis*.

Summary of progress and main findings

- *A. saligna* –Genetic diversity paper and fodder quality paper have been published in *Tree Genetics and Genomes Animal Feed Science and Technnology*. Mating system paper has been submitted to *Silvae Genetica*.
- *S. album* – Genetic diversity is being analyzed in a representative collection of germplasm with microsatellites and cp DNA markers.
- *E. occidentalis* – Trees in a salinity / waterlogging trial are being genotyped to determine genetic relationships. Genotypes have been determined and are currently being analyzed with salinity and waterlogging data.

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 manner without risk of genetic contamination and hybridization in natural populations.

Future directions (next 12-18 months)

- Reports and journal papers will be written for *A. microbotrya*, *E. cladocalyx*, *E. marginata* and *S. album*.
- Genetic relationships between *E. occidentalis* trees will be determined and correlated with fitness of progeny from crossing experiment involving close and distance crosses.

DEC Regions

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

IBRA Regions

Geraldton Sandplains, Esperance Plains, Swan Coastal Plain, Avon Wheatbelt, Yalgoo, Coolgardie, Mallee, Murchison, Jarrah Forest.

NRM Regions

Avon, Northern Agricultural, Rangelands, South West, South Coast.

Identification of seed collection zones for rehabilitation

SPP # 2006/008

Team members

M Byrne (0.1), D Coates (0.1), S McArthur (0.5), L Wong (0.5); Total (1.2).

Context

The Sustainable Forest Management Division of DEC provides guidelines to the Forest Products Commission on seed collection zones for forest rehabilitation. Rehabilitation of sites through revegetation requires knowledge of the genetic adaptation of the species to the sites in order to manage these sites on an ecologically sustainable basis. This requires an understanding of the genetic structure and local adaptation of the species.

It aligns with KRA 2.2 and 3.8 and Sustainable Forest Management Priorities 3A and 3C.

Aim

To identify appropriate seed collection zones (provenances) for species being used for rehabilitation. Initial work is focused on species in the jarrah and karri forest where seed is used for rehabilitation

after logging.

Summary of progress and main findings

- *Bossiaea ornata* – Microsatellite markers have been developed
- *Kennedia coccinea* –Microsatellite markers have been developed.

Management implications

- Knowledge of genetic structure and local adaptation will enable identification of appropriate seed collection zones for rehabilitation of forest areas in order to maintain the genetic integrity of the forest on a sustainable basis.

Future directions (next 12-18 months)

- Genetic analysis will be undertaken for *B. ornata* in 20 populations for which DNA has been extracted.
- Samples of *K. coccinea* will be collected, DNA extracted and genetic analysis commenced.

DEC Regions
South West, Warren.

IBRA Region
Jarrah Forest.

NRM Regions
Avon, South West.

Management of weed risk in perennial land use systems

SPP # 2004/003

Team members
M Byrne (0.2), L Stone (1.0), J Sampson (1.0); Total (2.2).

Context
The development of perennial-based land use systems for the management of dryland salinity promises significant environmental and economic benefits, but there are also risks to existing natural biodiversity. These risks include the establishment of new plant species as environmental weeds, hybridization with native species and gene flow from cultivated populations into natural populations.

It aligns with KRA 3.7, 3.8 and 3.11 and Nature Conservation Priority 3G.

Aims

- To develop and implement procedures for management of weed risk in the form of assessment and management protocols to be applied to all germplasm under development within the CRC for Plant-Based Management of Dryland Salinity (CRC PBMDS).
- To determine the mechanisms, extent, implications and management of genetic risk for selected taxa in commercial development.

Summary of progress and main findings

- Database of field trial species and sites is being maintained.
- Weed risk management protocols were introduced to CRC researchers and representatives from Weeds CRC and some NRM / CMA groups via training workshops held in WA, SA, NSW and Vic.
- Continued refinement of weed risk management protocols based on feedback from workshops,

particularly predicting the potential distribution of species.

- Development and ratification of an environmental weed risk policy in the CRC PBMDS.
- Continued involvement in national discussions on improvements to border and post-border weed risk assessment, including teleconferences and an upcoming workshop.
- Continued research study commenced investigating flower: fruit production in variants of *Acacia saligna* under common environmental conditions, which may lead to the ability to select for less weedy cultivars.
- Commenced small research study on the impact of the exotic species *Plantago lanceolata* on regeneration of native flora following a fire.
- Extensive pollen dispersal has been determined between planted *E. loxophleba* ssp *lissophloia* and natural *E. loxophleba* ssp. *supralaevis* at a site near Wubin. Over 50% of pollen received in a remnant stand originated from the planted mallees up to 2 km away.
- Genetic analysis of differentiation and population structure in *Atriplex nummularia* is currently being undertaken on 10 Western Australian populations and 4 eastern Australian populations. Genotype data confirms the species is a polypoloid.

Management implications

- Introduction of a weed risk assessment procedure and culture into the Salinity CRC will reduce the risk of large-scale plantings of new perennial species becoming environmental weeds.
- Knowledge of gene flow will enable the risk of genetic contamination and hybridization to be assessed and lead to development of risk management guidelines.

Future directions (next 12-18 months)

- Continue database management as part of weed risk management strategy.
- Weed risk management training workshops to be delivered to CRC PBMDS researchers.
- Continue technical advice to CRC PBMDS researchers on weed issues.
- Continue liaison between CRC PBMDS and CRC AWM.
- Complete research into flower: fruit production in *A. saligna.*
- Continue research on impact of *P. lanceolata* on native flora regeneration after fire.
- Continue involvement in national discussions on approaches to post-border weed risk assessment.
- Continue the development of methods to deal with species of some weed risk but high agricultural value.
- Commence development of trial site hygiene protocols for use in pasture research to minimize risk of species escape or persistence.
- Write paper on gene flow between *E. loxophleba* subspecies.
- Complete analysis of genetic structure in *Atriplex nummularia.*

DEC regions

Midwest, Wheatbelt, South Coast.

IBRA regions

Geraldton Sandplains, Avon Wheatbelt, Esperance Plains, Mallee.

NRM Regions

Avon, Northern Agricultural, South Coast.

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

SPP # not yet allocated (combination of several previous research projects)

Team member
J Farr (0.2).

Context
In 1982 *Eucalyptus occidentalis* suffered extensive defoliation from a then unknown species of psyllid in the Lower Great Southern region of Western Australia.

In line with Corporate priority 5 and 12, KRA 2 and 3.

Aim
To understand the biology and population dynamics of this new outbreaking psyllid on *E. occidentalis*.

Summary of progress and main findings

- No activity this year.

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 directions (next 12-18 months)

- Prepare manuscript.

DEC Regions
Wheatbelt, Warren, South Coast.

IBRA Regions
Avon Wheatbelt, Esperance Plains, Mallee, Jarrah Forest.

NRM Regions
Avon, South Coast.

Quantitative population monitoring of gumleaf skeletonizer (GLS), *Uraba lugens*

SPP # 93/0103

Team member
J Farr (0.01).

Context
In 1982 an extensive outbreak of *Uraba lugens* occurred on jarrah throughout the southern jarrah forest and persisted for nearly 10 yrs.

In line with Corporate Strategy 1.5 (protect biodiversity from threatening processes), Corporate Priority 12, KRA 2 and 3 and sub output SFM 3K.

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

Summary of progress and main findings

- No activity this year due to focus on other higher priority research projects.

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 directions (next 12-18 months)

- Data on population levels (using a cherry picker) to be incorporated into an internal report.
- To incorporate findings from this study into the development of a forest health surveillance program.

DEC Region

Warren.

IBRA Regions

Jarrah Forest, Warren.

NRM Regions

South Coast, South West.

State Salinity Strategy wetland monitoring

SPP # 1998/0018

Team members

Fauna - A Pinder (0.1), D Cale (0.5), M Pennifold (0.4); 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 (0.4), S Elscot (0.1), Y Winchcombe (0.3), B Johnson (0.05), B. Muir (0.05); Groundwater - M Lyons (0.05), contracts; Total (3.1).

Context

Substantial loss of biodiversity is known to have occurred across the Wheatbelt of Western Australia over the past 100 yrs. The most pronounced physical changes at wetlands have been associated with clearing and salinization. Clearing has more or less ceased but salinization will continue to be expressed or many decades. While it is known that salinization is a major threat to wetland biodiversity, the relationship between its physical expression and loss of biodiversity are poorly documented and understood. This project began in 1997 and is intended to be a long-term project.

It addresses Corporate Priority 3, KRA 2 and 3 and Sub-outputs NC 2D and 3NC E, F and G.

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 to provide information that will lead to better decision-making.

Summary of progress and main findings.

- Program summary presented at Wetlands Co-ordinating Committee in March resulted in WCC statement of support and intra-departmental review of program at workshop in April endorsed continuation of the project in current form.
- *Fauna monitoring* – 2005 monitoring completed, A4 sheets on waterbird results to date circulated, work begun on scientific paper reporting whole of project results for Paperbark Swamp and Eganu Lake. Amphibian monitoring for Drummond Recovery Catchment wetlands in progress. Bryde Recovery Catchment wetland biodiversity survey in progress.
- *Surface water monitoring* – Surface water monitoring – Depth gauge network 'installation and

maintenance database' (1977-2006) created. Historical nitrogen data added to wetlands database. 2005 depth and water quality monitoring results added to database. 2006 monitoring completed. Data distributed to users. Maintenance of depth gauge network undertaken. Most gauge benchmarks surveyed to Australian Height Datum.

- *Wetland bathymetry* – completed mapping of lake bed, shoreline, inflow and outflow contours of Lakes Brown and additional areas of Mollerin Lake.
- Vegetation monitoring for 2004 completed, vegetation history at Paperbark and Eganu documented from aerial photographs as part of scientific paper, another scientific paper on 5 yrs monitoring of vegetation monitoring in the Lake Muir-Unicup wetland system published in the *Journal of the Royal Society of Western Australia*.
- *Ground water monitoring* - for 2004 completed, shallow groundwater monitoring bores and vegetation quadrated surveyed to DLI benchmarks and thereby to depth gauges.
- Management – contributed to Bryde, Buntine-Marchagee, Drummond, Muir, and Toolibin TAGs and provided advice to Warden Biodiversity Recovery Catchment, put together scheme for assessing the suitability of wetlands to receive drainage for Wetlands Co-ordinating Committee (endorsed by Cabinet Sub-Committee for the Environment).

Management implications

- Analyses of trends in depths, salinities and pH of 60 wetlands monitored for 20 or more yrs have revealed a number of wetlands undergoing diverse changes that warrant further investigation and corrective management.
- The loss of vegetation is continuing even at long-saline wetlands where the physical expression of salinity in water is more or less stable. Such wetlands also show declines in faunal use.
- 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.

Future directions (next 12-18 months)

- Continue monitoring according to current protocols.
- Institute biennial reporting of trends in depth, salinity, pH (acidity/alkalinity) and nutrients of monitored wetlands.
- Report on Lake Bryde aquatic biodiversity survey in first half of 2007/8.
- Report on trends in depth, salinity and pH (acidity/alkalinity) of monitored wetlands from 1978-2004 to be completed.
- Investigations into causes of changes in depths and/or salinities of several monitored wetlands to be initiated.
- Complete paper analyzing trends in surface and groundwater salinities, vegetation condition and fauna at Paperbark Swamp and Eganu Lake.
- Begin producing pamphlets on aquatic invertebrates at monitored wetlands.
- Arrange to publicize results of the monitoring to date through media and presentation to NRM groups.
- Complete preparation of bathymetric maps and depth-volume calculators of Lakes Brown and Campion.
- Undertake bathymetric mapping of additional monitored wetlands.

DEC Regions

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

IBRA Regions

Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee.

NRM Regions

Avon, Northern Agricultural, South West, South Coast.

Monitoring stream biodiversity (KPI 20 for Forest Management Plan)

SPP # 2006/002

Team members

A Pinder (0.15), B Smith (0.5), TO to be appointed (0.1); Total (0.75).

Context

Key Performance Indicator 20 of the Forest Management Plan requires that monitoring of aquatic macroinvertebrates be undertaken in a selection of streams to provide information on trends in aquatic biodiversity across the forest, particularly in relation to logging and associated forest management. It is intended that no widespread and sustained loss should occur as a result of human activities.

This project was initiated in 2004/05 to meet KPI 20 and aligns with Corporate Priority 9 and KRA 2.

Aim

To monitor richness of aquatic macroinvertebrate families (and species richness within selected orders) at 50 sites in south-west jarrah and karri forest each spring.

Summary of progress and main findings.

- Sites were selected, groups to be identified to species level were determined, and a sampling protocol adopted (the AusRivAS box-sampling method).
- The second round of sampling was completed in 2006. Macroinvertebrate identification and water chemistry analysis have been completed for these samples.
- A report summarizing the first 2 years data was produced.

Management implications

- None to date.

Future directions (next 12-18 months)

- Data from the third round of sampling to be analyzed, including use of the AusRivAS model.
- Third round of sampling to undertaken in spring 2007.
- Publish a paper describing typical biodiversity of forest stream sites.

DEC Regions

South West, Swan, Warren.

IBRA Regions

Jarrah Forest, Warren.

NRM Regions

Swan, South West, South Coast.

Bushfire CRC Project 1.4: Improved methods for the assessment and prediction of grassland curing

SPP # not yet allocated

Team members

J Hollis (CRC-funded TO) (0.3), L McCaw (0.05), I Radford (0.05), K White (0.05), E Hatherly (0.05), R Butler (0.05), S Watkin (0.03), N Warnock (0.02); Total (0.6).

Context

Grassland curing has a significant effect on bushfire behaviour, particularly the development and subsequent rate of spread of a fire. Australian and New Zealand fire behaviour models and fire danger rating systems require grassland curing as an input to predictions of fire danger and fire spread. Outputs from fire danger rating systems are used by fire management agencies to determine fire danger and to aid in fire management activities such as determining fire season status, resource allocation and imposition of restrictions on activities. These decisions can have significant economic and social impacts on local communities. Similarly, predictions of rate of spread and headfire intensity based on grassland fire behaviour models assist in fire suppression decision-making, and in decision making about prescribed burning. The degree of curing is currently assessed visually or by satellite remote sensing using an index based on the reflective properties of grasses at different wavelengths. Improved techniques for estimation of grassland curing are particularly important for implementing fire management programs in remote areas of northern and interior Western Australia.

It aligns with Corporate Priorities 3 and 10, and KRA's 2.1, 3.11 and 3.12.

Aims

- To extend current grassland curing field data across Western Australia so that improved methods for the assessment and prediction of grassland curing are robustly applicable over a wide range of grassland types.
- To enable and contribute to the development and validation of improved methods for the assessment and prediction of grassland curing by;
    - Establish 5 regional sampling sites representative of the major grasslands of Western Australia.
    - Collect, analyse and provide grassland curing data from these various grasslands.

Summary of progress and main findings

- Field sampling sites have been established at:
    - Parry Lagoons (1) Wyndham, East Kimberley Region.
    - King Leopold National Park (3) West Kimberley Region.
    - Lorna Glen (1) Goldfields Region.
    - Katanning Agricultural Research Station.
    - Simcocks Private Property (1) Warren Region.
- Field work has included site characterization and grass sampling to validate the methodology for assessment of grass curing and fuel moisture content. Preliminary grass curing results have captured the early curing process for the Kimberley region. Progress for grass curing assessment has included capturing one curing cycle for the Kimberley, Goldfields, Wheatbelt and Warren regions.
- Data collection has also enabled preliminary anaysis of remote sensing techniques and their applicability to the grasslands of Western Australia.

Management implications

- Development of methods for assessing and predicting current and future levels of curing in grasslands, focusing on 2 main areas, remote sensing applications and pasture (grass) growth modeling.

Future directions (next 12-18 months)

- Further field data collection is required to build on the Australian/New Zealand dataset that will enable the development and validation of methodology and remote sensing techniques.

DEC Regions

Kimberley, Goldfields, Pilbara, Wheatbelt, Warren.

IBRA Regions
Jarrah Forest, Central Kimberley (Pentecost), Gascoyne (Carnegie), Victoria Bonaparte.

NRM Regions
Rangelands, Avon, South West.

Effects of fire on plant species, communities and fauna habitat at Two Peoples Bay Nature Reserve
SPP # not yet allocated

Team member
A Hopkins (0.4).

Context
Understanding immediate and long-term effects of fire on the floristics, community dynamics and habitat characteristics of south coast kwongan landscapes is important for developing and implementing ecologically appropriate fire regimes throughout this region. The study in this project, at Two Peoples Bay Nature Reserve, involves detailed survey of floristic composition and vegetation structure in a permanently-marked (fenced) plot prior to the experimental fire, monitoring the fire, and resampling 2m x 2m quadrats within that larger plot at pre-determined intervals after the fires.

It aligns with Corporate Priorities 10 and 12, KRA 2 and 3 and sub-output NC 3K.

Aim
To improve understanding of the ecological effects of fire at a landscape scale in kwongan vegetation growing on sand over coastal limestone at Two Peoples Bay Nature Reserve, as a surrogate for the coastal kwongan throughout the reserve, and to disseminate that emerging knowledge to Departmental staff involved in the management of conservation lands along the south coast.

Summary of progress and main findings

- The 625 m^2 study plot was established in mid-1976, sampled and then burnt in September 1976. The plot contains 64 2 m x 2 m quadrats, of which a randomly selected 5 were sampled at each sampling event. Sampling involved complete harvesting of all above-ground biomass by species. At years 5 and 10, the vegetation outside the fenced plot was also sampled, to ascertain the relative impact of grazing and trampling by grey kangaroos (and other small mammals).
- Sampling is complete, the harvested material has been sorted, dried and weighed, and data compiled in hard copy.
- In 2007 the data were entered into a digital database for more detailed analysis. These data are now being analyzed.
- The fire in September 1976 reduced the above-ground biomass from 15.5 tonnes per hectare to 3.2 tph (oven dry weight). The remaining biomass consisted entirely of woody material which was too thick to burn under the prevailing conditions - the woody material was generally greater than 0.5 cm in diameter.
- In the absence of grazing by kangaroos the above-ground biomass of the vegetation returned to pre-fire levels within about 7 years. After 10 years, ungrazed vegetation weighed 17.4 tph and the rate of accumulation appeared to be tailing off.
- Grazing had a pronounced effect on the accumulation of biomass. At year 5, the grazed vegetation was only half the weight of the ungrazed vegetation. At year 10, this proportion was 74%.
- Maximum species richness occurred at year 5 of the study and declined gradually thereafter. Six species appeared late in the study; these included *Agonis flexuosa* which is now very prominent in the plot, and 5 species of small herbs characteristic of disturbed sites, of which 2 are weeds. *Dryandra sessilis* also became prominent towards the end of the study. This species is known to have the capacity to invade relatively undisturbed vegetation. Several species appeared in the

plot soon after the fire and were not present by year 10. These were mainly annuals and short-lived perennials.

- By year 5, all resprouting species and all but one fire-sensitive, obligate seed regenerating species had reached reproductive maturity. *Dryandra sessilis* reached reproductive maturity by year 7 of the study.
- The study plot was not habitat for Noisy Scrub-birds, but adjacent to extensive areas of such habitat. This species is known to reoccupy areas of sub-optimal habitat like the nearby sites between 17-19 years after fire.
- Western Bristlebirds occurred in the area of the strategic fuel-reduced zone (where the study plot is located). They recolonized areas of habitat 4-6 years after fire. It is known that this kwongan vegetation remains suitable habitat for Bristlebirds for at least 45 years after fire, although at that age bird density is lower than in 20 year old vegetation. While the structure of the kwongan may remain suitable, its productivity in terms of seed production and insect abundance may decline with age.

Management implications

- A minimum between-fire interval for intact coastal kwongan vegetation would appear to be around 20 years.
- Further work is needed to determine the impacts, if any, of total fire exclusion on vegetation, floristic composition and habitat values for Noisy Scrub-birds at Two Peoples Bay Nature Reserve.

Future directions (next 12-18 months)

- Further data analysis and write-up.
- Liaison with South Coast Region staff regarding the management of Two Peoples Bay Nature Reserve specifically and other conservation lands with extensive areas of coastal kwongan.

DEC Region
South Coast.

IBRA Region
Jarrah Forest (Southern), Esperance Plains (Fitzgerald).

NRM Regions
South Coast.

Effects of fire on plant species and communities at Tutanning Nature Reserve

SPP # 93/0090

Team member
A Hopkins (0.1).

Context
Understanding immediate and long-term effects of fire on the floristics and community dynamics of wheatbelt landscapes is important for developing and implementing ecologically appropriate fire regimes throughout this region. The 2 studies in this project, both at Tutanning Nature Reserve, involve detailed survey of floristic composition and vegetation structure at fixed sites prior to the experimental fires, monitoring the fire, and resampling the fixed sites at pre-determined intervals after the fires.

It aligns with Corporate Priorities 10 and 12, KRA 2 and 3 and sub-output NC 3K.

Aim
To improve understanding of the ecological effects of fire at a landscape scale in the various

vegetation types/ plant communities occurring at Tutanning Nature Reserve, and to disseminate that emerging knowledge to Departmental staff involved in the management of conservation lands throughout the central wheatbelt.

Summary of progress and main findings

- A total of 98 permanently-marked sites have been established in the 2 blocks burnt under experimental conditions in 1985 and 1990.
- These sites have been sampled and resampled for up to 15 years following the respective fires.
- A further 15 permanently-marked sites were sampled prior to a management burn which took place in April 2007. In this block, in the patch of species-rich heath where rock sheoak *Allocasuarina huegeliana* was encroaching, all plants of the *A. huegeliana* in an area of 30 m x 30 m were cut and removed.
- The data have been databased, and are now being analyzed.
- It is difficult for operational staff to implement prescribed fires that truly simulate the normal hot summer fires that would have occurred in this region prior to settlement, because of the lack of management resources including guidelines. Fires tend to be cool, and rarely affect the crowns of even low trees. Only in patches of open to closed shrublands and heath do these fires become intense, and consume most of the above-ground biomass.
- Regeneration after these cool fires is largely predictable: resprouting species regenerate vegetatively and obligate seed regenerating species regenerate through seedling establishment. In some cases, short-lived perennial species appear and become very prominent, then die leaving substantial seedbanks of long-lived seed in the soil.
- Most fire-sensitive, obligate seed regenerating species with above-ground seed storage reached reproductive maturity within the period of the study. These data are presently subject to detailed scrutiny.
- Rock sheoak *Allocasuarina huegeliana* is sensitive to fire of even moderate intensity. Once the crown dies, the vast seedbank held in fruits in the canopy is released. These seeds germinate readily, and become established in the absence of predation/grazing. Plants reach reproductive maturity in about 12 years.
- *A. huegeliana* seeds are winged, and disperse widely in the wind. Seedlings can establish in the absence of fire, so there are situations where this species is becoming increasingly important in the vegetation of the reserve, and elsewhere in the wheatbelt.

Management implications

- At this juncture, it appears that the only practical method of controlling the encroachment by *Allocasuarina huegeliana* is to use fire. The fire has to be sufficiently intense to burn the crowns of the *A. huegeliana* and destroy the seed bank.
- Scientifically-based guidelines for the appropriate fire regimes (frequency, season, intensity and spatial patterning of burning) to achieve a range of land management objectives are being developed.

Future directions (next 12-18 months)

- Complete analysis of data and prepare report.

DEC Region
Wheatbelt.

IBRA Region
Avon Wheatbelt.

NRM Region
Avon.

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

SPP # 2000/03

Team member

J Kinal (1.0).

Context

This study is a long-term experiment that was established in 1999 to address part of Ministerial Condition 12-3 attached to Forest Management Plan 1994-2003. Min Con 12-3 states that DEC shall monitor and report on the status and effectiveness of silvicultural measures in the intermediate rainfall zone to protect water.

This study aligns with KRA 2.2, 3.8 and 3.11 and SFM sub-output 3N.

Aim

To investigate the hydrologic impacts of timber harvesting and associated silvicultural treatments in the intermediate rainfall zone (IRZ, 900 – 1100 mm/yr) of the jarrah forest.

Summary of progress and main findings

- Overstorey crown density, basal area and stocking were remeasured in spring/summer 2006.
- 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.
- Groundwater levels have continued to rise, relative to the control catchment, and have not reached a peak response 6 yrs after the harvesting and silvicultural treatments and 4 yrs after the silvicultural burn. Groundwater has risen an average 1.38 m in the intensive-treatment catchment and an average 0.96 m in the standard-treatment catchment.
- The treatments have had no measurable effect on water quantity or quality in either the intensive- or the standard-treatment catchments.

Management implications

- Results will enable an informed assessment of the adequacy of jarrah forest silvicultural practices in protecting water quality from the impact of timber harvesting and a sound basis on which revision of the practices can be made.

Future directions (next 12-18 months)

- Monitoring of groundwater levels, stream flow, stream salinity, stream turbidity and rainfall should be continued for at least another year or until the responses to the treatments have peaked.
- Complete final SPP report
- Publish the research.

DEC Region

Swan.

IBRA Region

Jarrah Forest.

NRM Regions

South West, Swan.

Directory of important wetlands in Australia: revised editions

SPP # 1999/0014

Team members

J Lane (0.15), G Pearson (0.2), A Clarke (0.6), S Elscot (0.25); Total (1.2).

Context

The first edition of *A Directory of Important Wetlands in Australia* was published in 1993, as a co-operative project between the State, Territory and Commonwealth Governments of Australia. Second and third editions were published in 1996 and 2001. The *Directory* provides a listing of wetlands identified as being of national significance. It is an ongoing project; more wetlands are added as knowledge of Australia wetlands and their many values grows and as circumstances change. The *Directory* provides a basis, but not the only basis, for prioritizing wetland conservation activities in Western Australia and nationally. The Team leader has had responsibility for this project in WA since its inception.

This study aligns with Corporate Priorities 5, 6, KRA 3 and sub-output NC 3C. Current work (commenced 2003) is on wetlands of remote and under-represented IBRA Regions of WA.

Aims

- To prepare revised editions of the Western Australian Chapter of *A Directory of Important Wetlands in Australia*, incorporating additional wetlands and information as knowledge increases and circumstances change.
- To periodically update the national database of Directory wetlands.

Summary of progress and main findings

- Site managers and others with substantial relevant knowledge of remote wetlands have been contacted and site visits and surveys conducted to collect field data and other information to support site listings.
- Aquatic invertebrate specimens have been sorted in preparation for specialist taxonomic identification.
- Botanical specimens have been identified and mounted for lodgment in the WA Herbarium collection.
- Waterbird data has been analyzed and synthesized for inclusion in site descriptions.
- Information concerning cultural values, site management, threats and related issues has been collated.
- Preparation and enhancement of descriptions of candidate and existing remote Directory sites has largely been completed.
- The Western Australian component of the National Directory will be updated in 2006 to include new sites and enhanced site descriptions.

Management implications

- Literature search, field survey results and interviews has led to identification of nationally important wetlands, values and threats and provide a basis for conservation and wise management of these wetlands.

Future directions (next 12-18 months)

- Specialist taxonomic identification of aquatic invertebrate from remote wetlands will be completed, data analyzed and information synthesized.
- Descriptions of proposed new sites for the Directory will be finalized, together with enhanced descriptions of existing sites.
- The Western Australian component of the Directory will be updated in 2006 to include new sites and enhanced site descriptions.

DEC Regions

The Directory is an important resource document for all DEC Regions. Current work is focused on the Kimberley, Pilbara, Goldfields, Midwest, South Coast and Wheatbelt DEC Regions.

IBRA Regions

The main focus at present is on Central Ranges, Coolgardie, Gibson Desert, Great Victoria Desert, Hampton, Little Sandy Desert, Mallee, Nullarbor, Ord Victoria Plains, Tanami and Yalgoo.

NRM Regions

The Directory is an important resource document for all NRM Regions. Current work is focused on the Rangelands NRM Co-ordinating Group.

Management of the Vasse-Wonnerup wetlands

SPP # 1999/0017

Team members

J Lane (0.15), Y Winchcombe (0.1); Total (0.25).

Context

There is a long history of mass fish deaths in the lowest reaches of the Ramsar-listed Vasse-Wonnerup wetland system. The incidence and severity of deaths can be reduced by timely openings of the entrance sandbar and 2 sets of floodgates. Careful management of flows and water levels is needed to prevent adverse impacts on fringing vegetation, waterbirds and adjoining properties. Following a mass fish kill in 1997, DEC led the establishment of an inter-agency technical working group to co-ordinate relevant agency activities. This lead role is being maintained.

This project aligns with Corporate Priorities 3, 5 and 12, KRA 2 and sub-output NC 2D.

Aims

- To perform a lead role in the management of water levels, flows and salinities in the Vasse-Wonnerup wetland system.
- To undertake monitoring programs that will enable impacts of Vasse-Wonnerup water level, flow and salinity regimes to be assessed. The principal issues of interest in this project are impacts on waterbird populations, fringing plant communities and adjoining properties and the occurrence of mass fish deaths.

Summary of progress and main findings

- A meeting of the inter-agency Vasse Estuary Technical Working Group was convened to decide arrangements for 2005 / 06 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.
- Monitoring of fish activity and water levels at the floodgates was undertaken by team members with DEC Blackwood District backup during 2005 / 06. The Vasse estuary floodgates 'fish gate' was opened for periods in summer-autumn to maintain the target water level, allow fish to pass and kill potentially toxic algal blooms. The Wonnerup estuary floodgates fish gate was opened periodically to maintain a minimum level sufficient to allow fish to be released if necessary.
- 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, flows and fish movements were successfully managed throughout summer-autumn of 2005 / 06. 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 directions (next 12-18 months)

- The VETWG will be convened as necessary to decide on management, monitoring and other responsibilities during 2006 / 07.
- Monitoring of water levels and fish activity during summer-autumn will continue. Gates will be opened as necessary to manage water levels and release fish.
- Public enquiries concerning management of the wetlands will continue to be responded to.
- A concise report will be prepared, recording water levels, floodgate openings, fish releases and mass fish death incidents in the Vasse-Wonnerup system since the December 1997 report of Lane, Hardcastle, Tregonning and Holtfreter.

DEC Region

South West.

IBRA Region

Swan Coastal Plain.

NRM Region

South West.

Monitoring post-fire effects from the 2001 Nuyts wildfire

SPP # 2006/001

Team members

G Liddelow (0.1), B Ward (0.05), R Cranfield (0.05) P Van Heurck (0.1) L McCaw (0.05), Frankland District Staff as required; Total (0.35).

Context

Understanding the effects of different fire regimes is important for developing and implementing ecologically appropriate fire regimes and for managing fire for the protection of life and property. This study was established to take advantage of the opportunity presented by an unplanned fire that was ignited by lightning in March 2001 following an extended period of below average rainfall.

The study aligns with Corporate Priority 10, KRA 2 and 3 and sub-output NC 3K.

Aim

To monitor impact of severe wildfire in karri / tingle forest on plants, invertebrates, vertebrate fauna and stand structure.

Summary of progress and main findings

- Fourth year of post-fire data collected for plants, mammals, reptiles, amphibians and stand structure.
- Crown condition and seedling regeneration were assessed in December 2005. Crown condition of mature karri and red tingle has stabilized, although isolated mortality of trees continues. Karri, red tingle and marri have regenerated vigorously in areas where the overstorey canopy has been fire damaged, with dominant saplings up to 5 m tall.
- Vascular plant species richness and abundance data were collected for the fourth year post fire in early May 2005. Species from 20 1x1m quadrats per plot ranged in number from 15 to 35 per plot depending on landform. Vouchering of species was done at time of measurement and less than 10% of species were flowering.
- The number of bird species recorded in the study area has varied between 31 and 39 over the 5 yrs since fire. Some of the birds typical of open country that were present in the early post-fire stages have disappeared as the understorey has become denser. The normal suite of birds associated with dense forest understorey karri/tingle forest have become well established in the area and the densities of birds appears to be the same as similar types of forest. The red-eared

firetail finch became widespread in the study area in the third year after fire.

- Quokka have become established in all the suitable habitat within the burn area, and currently occupy some sites that could be considered marginal habitat. This is probably a temporary consequence of fire-induced changes in vegetation structure.

Management implications

- This study contributes to the development of ecologically appropriate fire regimes for tall forests in southern Western Australia. Results to date have indicated that long-term fire exclusion can result in very severe fire impacts on many components of the forest ecosystem and that large scale high intensity fires can have undesirable ecological outcomes including simplification of plant population structure and depletion of seed banks.

Future directions (next 12-18 months)

- Data are being analyzed for consolidation in a 5 year progress report, and selected datasets will be prepared for scientific publication.

DEC Region
Warren.

IBRA Region
Warren.

NRM Regions
South Coast, South West.

Long-term monitoring of timber harvesting on bird populations in south-west forest areas

SPP # 1994/008

Team Members
G Liddelow (0.1), C Vellios (0.1); Total (0.2).

Context
Understanding the long-term effects of timber harvesting on the bird populations in karri and jarrah forests is important for predicting how bird species and numbers of individuals change with time since regeneration.

Aim
To quantify the effects of timber harvesting and silvicultural practices in the karri and jarrah forests on birds.

Summary of Progress

- Numbers of birds at Gray 20 yrs after regeneration were lower than 5 yrs ago probably due to senesce of understorey shrubs. Only long lived understorey species such as *Trymalium* and *Allocasuarina* now persist.
- Counts were carried out at the 16 Kingston jarrah sites in spring 2005.
- Numbers at Kingston were consistent with last year and as crown separation is now occurring the suites of birds should separate out into their own niches.

Management Implications

- This study evaluates the effect of past silvicultural practices in the karri and current silvicultural practices in the jarrah forests.

Future directions (next 12-18 months)

- Counts at Grey will be repeated in 2010 (25 yrs after regeneration) or prior to any harvesting that may occur in the interim.
- Counts to be done at Kingston sites in 2011 (15 yrs after regeneration).
- Analysis of data from both sites is underway.

DEC Region
Warren.

IBRA Regions
Jarrah Forest, Warren.

NRM Region
South West.

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

SPP # 97/03

Team members
L McCaw (0.3), G Phelan (0.3); Total (0.5).

Context
Successful fire management depends on the ability to reliably predict the behaviour of fires burning under a wide range of fuel and weather conditions. Fire management policy and practice must be underpinned by a sound understanding of fire behaviour so that the most effective and appropriate practices are employed for particular circumstances. This project has addressed recognized limitations in previous fire behaviour prediction models for dry eucalypt forests.

It aligns with Corporate Priority 10, KRA's 2 and 3, and sub-outputs SFM 3D and SFM 3H.

Aims

- 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 analyzed to identify the key variables influencing fire spread. Fuel variables that describe vegetation structure and condition are more strongly correlated with rate of spread than is surface litter fuel load alone. Fuel variables can account for site-related differences in vegetation structure and density, making models transportable across a range of site conditions. Fuel structure and condition can be described for operational purposes using a simple hazard scoring system that can 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 that are 100 m or wider at the headfire zone.
- A comprehensive final project report has been prepared describing the experimental methods, key findings and the development of a new fire spread model for dry eucalypt forest. This report is accompanied by a DVD containing selected video clips illustrating important fire behaviour phenomenon.

Management implications

- Fire managers will be provided with the best available tools to predict fire behaviour to achieve prescribed burning objectives and safe wildfire suppression.

Future directions (next 12-18 months)

- A manuscript comparing the behaviour of experimental summer fires in relation to predictions from the Forest Fire Behaviour Tables for Western Australia and the McArthur Forest Fire Danger meter has been submitted to *Australian Forestry* for review .
- The final project report including fuel assessment procedures and a new fire behaviour guide will be released in August 2007.

DEC Regions

South West, Swan, Warren.

IBRA Regions

Jarrah Forest, Warren.

NRM Regions

South Coast, South West, Swan.

Increasing productivity of karri regrowth stands by thinning and fertilizing

SPP # 93/106

Team members

L McCaw (0.05), G Phelan (0.3); Total (0.35).

Context

Thinning to concentrate growth on selected trees is an important component of the silviculture of regenerated karri forest and contributes to achievement of forest structure and productivity goals. Thinning also benefits forest protection by reducing the likely impacts of drought, and facilitating the re-introduction of prescribed fire into regrowth stands. This study quantifies the growth response of a number of different stands on a range of site types and contributes important information on long-term growth and stand development.

This study aligns with Corporate Priority 9, and KRA's 3.8 and 4.3.

Aim

To provide information about tree and stand growth response to 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

- Re-measurement of the Warren thinning experiment was completed during 2005 (tree height, stem diameter, bark thickness, crown radius). This is 5 yrs since the last measurement, and 20 yrs since the experiment was established in a stand that was 13 yrs old at the time.
- The incidence of *Armillaria* scarring on trees was also assessed. Indications are that since 2000 there has been only limited tree mortality, and many bole scars have occluded.
- The epiphytic fern *Asplenium aethiopicum* has successfully recolonized regrowth forest within 3

decades of disturbance by clearfelling and fire. Deep moss beds on large fallen logs are the preferred habitat for *A. aethiopicum.* Findings are reported in McCaw (2006) *Journal of the Royal Society of Western Australia* **89**, 119-122.

Management implications

- Growth response from thinning is factored into scheduled timber yields from the karri forest, and it is important that the magnitude of the response be validated by periodic measurements. Potential losses from *Armillaria* root disease also need to be quantified.

Future directions (next 12-18 months)

- Undertake a review of silvicultural experiments in conjunction with Forest Management Branch to determine priorities for re-measurement in the period 2007-2011. This will take into consideration requirement of the Forest Management Plan and emerging issues including climate change.

DEC Region
Warren.

IBRA Region
Warren.

NRM Region
South West.

Effect of fire on groundwater recharge to the Jewel Cave karst system

SPP # 2003/009

Team members

L. McCaw (0.05), S Eberhard (honorary collaborator), I Dumbrell (FPC), CaveWorks (external collaborators); Total (0.05).

Context

Limestone karst landforms underlie several regionally significant conservation reserves in the south-west of Western Australia. Prescribed fire is used to manage vegetation condition and fuel loads used in these reserves, and there is a need to better understand how fire regimes affect the quantity and characteristics of subterranean water flow. This study investigates the relationship between fire and groundwater in a karri forest ecosystem at Jewel Cave in the Leeuwin Naturaliste National Park. Declining groundwater levels in the cave over the past 5 decades cannot readily be explained by climatic variation, but are considered to represent a threat to subterranean root mat communities.

This project aligns with Corporate Priority 10, KRA's 2.1, 3.11 and 4.1, and sub-outputs NC 4C.

Aim

To quantify the effects of a prescribed burn on groundwater recharge in a karst aquifer, through measurement of rainfall, leaf area, fuel load, soil water content and movement, infiltration rate and chemistry of cave dripwater, cave groundwater levels.

Summary of progress and main findings

- Monitoring of selected variables over a second rainfall year post-burn was undertaken. This included monitoring of daily rainfall, dripwater chemistry (Mg and Cl), infiltration rate and cave water levels (most field work undertaken by CaveWorks, Augusta-Margaret River Tourism Association). Fuel accumulation was measured in Jan 2005 and Feb 2006. Limited monitoring of soil water content and movement was undertaken.
- Post-burn monitoring has now been completed.
- The overall multi-year declining trend in cave groundwater levels continued in response to the

long-term trend in declining rainfall.

- Groundwater levels in the Jewel Cave karst system have declined to a critically low level and the conservation status of the Threatened Ecological Community (TEC Cave Root Mat Community No. 1) remains Endangered (critical). The potential effects of land uses on private property adjoining Jewel Cave has been examined by the Department of Environment. Simulation modelling of water balance for the Jewel Cave system suggest that the rate of recharge necessary to maintain or raise current groundwater levels greatly exceeds any gains likely to be achievable through increased rainfall effectiveness linked to changes in interception by the litter and understorey.

Management implications

- Long-term climate modelling predicts that the trend of declining rainfall in the south west will continue. This has implications for both fire management and the management of groundwater resources and groundwater dependent ecosystems including the TECs in the Jewel Cave karst system and other listed TECs in the Leeuwin Naturaliste region and elsewhere in WA (e.g. Yanchep). Fire clearly affects recharge to groundwater, so fire management planning needs to consider the effects on groundwater recharge and groundwater dependent ecosystems, especially in karst areas. Quantification of the effect of fire on groundwater recharge in karst systems of SW WA will assist planning and management of fire regimes in context with climate change and the conservation of groundwater dependent ecosystems.

Future directions (next 12-18 months)

- No further work has been undertaken on this project during the past 12 months, and future work will depend on the availability of suitably skilled staff and funding.

DEC Region
South West.

IBRA Region
Warren.

NRM Region
South West.

Fire induced mosaics in semi-arid shrublands and woodlands

SPP # 93/0086

Team members
L McCaw (0.10).

Context
Extensive tracts of shrubland and woodland occur in semi-arid areas of southern Western Australia, much of it as unallocated crown land. These lands are sparsely populated and significant tracts have not been extensively disturbed by pastoralism, mining or clearing. Summer lightning storms regularly ignite bushfires that may burn for months with minimal or no intervention. The spread of fires is determined by the distribution of vegetation types, low fuel areas such as salt lakes and rock outcrops, and the pattern of past fires. Intense fires can cause long-term changes to the structure of eucalypt woodland communities and in some cases it is difficult to reconcile the long-term persistence of woodlands with the pattern of burning observed over the past few decades. Remote semi-arid lands provide a valuable opportunity to examine natural disturbance regimes which can be compared with more populated and intensively managed landscapes in the south-west.

Project aligns with Corporate Priority 10 and 12, KRA's 2 and 3, and sub-output NC 3K..

Aims

- To examine the frequency, intensity and cause of fires in semi-arid landscapes dominated by woodland and shrubland.
- To document the age-class (time since fire) distribution for woodlands and shrublands at a landscape scale.
- To document and interpret the response of vegetation structure to different fire regimes.

Summary of progress and main findings

- Alison O' Donnell has commenced a PhD project supported by the Bushfire CRC to document fire regimes over the past 50 years in a study area based on the Lake Johnson (1:250 000) mapsheet.
- Several field trips were undertaken in 2006 to validate fire history information gathered from air photographs, satellite imagery and tree rings from *Callitris* stems.
- A paper describing the distribution and ecology of *Callitris* in the woodlands and shrublands of southern Western Australia was presented to the Australian and New Zealand Institute of Foresters (ANZIF) conference in Coffs Harbour NSW in June 2007.

Management implications

- Fire managers will be provided with information about the consequences of intervention in fire regimes, or lack of it.

Future directions (next 12-18 months)

- Continue to support PhD project with field assessment of the effects of fire in woodlands.
- Participate in a proposed CERF project examining the potential of *Callitris* as a bio-indicator of decadal scale environmental change.

DEC Regions

South Coast, Goldfields.

IBRA Regions

Coolgardie, Esperance Plains, Mallee.

NRM Regions

South Coast, Rangelands.

Identification and monitoring of benthic invertebrate communities of tropical intertidal mudflats

SPP # 1999/15

Team member

G Pearson (0.2).

Context

It is important to facilitate a better understanding of the wildlife values of intertidal mudflats at Roebuck Bay, Eighty-mile Beach, King Sound and other tropical intertidal habitats through scientific examination and community interaction. Collection of baseline data, establishment of long-term monitoring and engagement of community are important for developing and implementing ecologically appropriate management regimes within a marine conservation reserve system (Roebuck Bay, Eighty-mile Beach). The monitoring programs, established in 1996 were designed as long-term studies involving international science input and volunteer recruitment.

They align with Corporate Priority 11, KRA 1-6 and sub-outputs NC2B, 2D, 3B, 3H, 4F and 6A.

Aim

To facilitate and participate in research on the wildlife conservation values of tropical intertidal mudflats including Roebuck Bay and Eighty-mile Beach and to foster local and wider community involvement and understanding of the wildlife conservation values of intertidal mudflats.

Summary of progress and main findings

Roebuck Bay

- 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. Supervisors: Dr T Piersma, G Pearson.
- Collaboration with community groups to establish a second Celebrate the Bay community based information forum in Broome in 2006.
- Continued collaboration in the Shorebird Conservation Project at Roebuck Bay with WWF, Rubibi and DEC.
- A study of the food webs of Roebuck Bay using stable isotopes was initiated in 2003. Preliminary results were reported in August 2004 and at the Celebrate the Bay community forum in Broome in June 2006.
- A collaborative study of the benthic ecology of the northern parts of the intertidal mudflats of Roebuck Bay was carried out in June 2006. Benthos, shorebirds and sediments were mapped at 600 sites.

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 2006/07.
- Funding was obtained from DEC's Wetland Project proposals. Initiated analysis of data collected from the Eighty-mile Beach monitoring ('Monanna') Project. Results to be reported in 2006.
- Completed 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 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 Beach and its hinterland.
- Management strategies and opportunities for research for both sites will be enhanced by collaboration with external research institutions and involvement of local and wider community.
- Improved community understanding of management issues at Roebuck Bay and Eighty-mile beach.

Future directions (next 12-18 months)

Roebuck Bay

- Continue collaboration with research partners in 2007-2008.
- Participate in Global Flyway Network proposal to satellite track Bar-tailed Godwit migration to and from Australia and NZ.
- Establish and develop a community based, DEC driven and led, monitoring program of nutrient inflows into Roebuck Bay through drainage systems and groundwater leaching from the wastewater treatment plant at Broome. Financial contributions from DEC West Kimberley, Port of Broome and Broome Shire have made possible an ongoing monitoring program that will foster better management of nutrient run-off and leachates into the Ramsar site.
- Analyse sediments from Geum Estuary (South Korea), Roebuck Bay, King Sound and 80 Mile Beach for nutrients.
- Analyse 600 sediment samples from Roebim06 for grain size distribution and nutrients.
- Progress towards MSc on geochemical approach to shorebird richness of tropical and temperate intertidal wetlands

Eighty-Mile Beach

- Progress towards a publication encompassing the conservation of wetland and cultural values of the coast between De Grey River and Cape Leveque.
- Analyse samples collected from 3 sites for nutrients for comparison with other shorebird sites.

DEC Region
Kimberley.

IBRA Region
Dampierland.

NRM Region
Rangelands.

Fire regimes and biodiversity decline in the Kimberley

SPP # not yet allocated

Team members
I Radford (0.5), L McCaw (0.05), A Beechey (1.0); Total (1.55).

Context
Recent studies in the Northern Territory have shown declines in small and medium mammals, some bird species and some shrubs. Increased intensity and frequency of fires have been blamed for biodiversity declines in otherwise intact landscapes. Studies in central Australian arid environments also highlight the strong influence of fire, combined with feral predators, on the abundance of mammal species. This evidence from both the tropical savannas and arid environments have obvious implications for northern regions in WA including the Kimberley, as these regions have also apparently undergone major shifts in fire regimes. No work has yet established a direct link between abundance of threatened animals and fire regimes in this region. This study will establish whether fire is a strong influence on abundance of threatened taxa in the Kimberley through studies in 3 Kimberley subregions; the Mitchell River, Purnululu and King Leopold. Studies will address whether fire influences biodiversity, and the ecosystem basis for these fire effects.

It aligns with Corporate Priorities 10 and 12, KRA 2 and 3 and sub-output NC 2B and 3K.

Aims

- To spatially quantify the fire history in the Mitchell River and Purnululu regions.
- To establish whether fire history influences abundance of threatened groups, particularly mammals, and to quantify recolonization rates for threatened species after fire.
- To link fire history and mammal abundance with vegetation and resource community (consumers including invertebrates and small vertebrates) attributes, which might explain the effect of fire.

Summary of progress and main findings

- Progress has been made towards applying an automated process to quantify fire scars from high resolution Landsat images in the high rainfall savannas of the Mitchell. This process is accurate on Laterite and basalt geology, but much less so on sandstone at this stage. Further work is being undertaken to increase accuracy on sandstone in high rainfall zones.
- Mammal, invertebrate and vegetation sampling is underway (June to Aug 07) at sites with differing time since fire in the Mitchell River region. Early results indicate a clear influence of recent fire on abundance of mammals. The most obvious environmental feature that differentiates recently burnt and longer unburnt habitats is herbaceous biomass. We will establish 24 study sites during this survey.
- A subset of study sites, with contrasting mammal abundance, will be used as model

environments to isolate factors correlating with fire effects. This will be important for identification of mechanisms underlying fire effects which can be experimentally tested in future studies.

Management implications

- With detailed information on time for full recolonization of mammal species post-fire we will be able to design optimal prescribed burn rotations to allow persistence of animals in savanna sandstone and laterite/basalt landscapes.

Future directions (next 12-18 months)

- Finalize Mitchell survey of sites along time-since-fire gradient (June-Aug 2007).
- Establish long-term monitoring sites at Mitchell for detailed analysis of habitat structure and resource dynamics (Aug-Dec 2007).
- Conduct wet season monitoring of Mitchell long-term sites (Feb-Mar 2008).
- Conduct Purnululu site survey (Apr-May 2008).
- Conduct dry season monitoring of long-term sites (Jun-Jul 2008).
- Complete manuscripts on:
    - Description of fire history from 1989 to present, including analysis of recent changes in fire regimes.
    - The influence of fire regime on mammal abundance, time to recolonization of burnt sites and putative mechanisms underlying fire effects.

DEC Region

Kimberley.

IBRA Regions

Northern Kimberley, Ord Victoria Plain, Central Kimberley.

NRM Region

Rangelands.

Armillaria spread in karri

SPP # 98/0006

Team members

R Robinson (0.2), J Fielder (0.4), G Phelan (0.1); Total (0.70).

Context

Armillaria root disease impacts significantly on the silviculture and management of karri regrowth forests. Levels of infection in young stands increase significantly following thinning on high quality sites. Infection impacts significantly on the mean total volume of a stand in the form of wood defect and mortality in residual crop trees. This study is designed to look at the options for control of Armillaria root disease at the stage of first thinning in karri regrowth forests on high quality sites.

It aligns with Corporate Priorities 3 and 9, and KRA 3. SFM output priorities 1, 2, 3, 4 and 5, and sub-outputs SFM 3A, 3J and 3P.

Aims

- To investigate control methods of *Armillaria* root disease in karri regrowth forest.
- To investigate the effects of management on *Armillaria* root disease in karri regrowth forest.
- To investigate how *Armillaria* root disease affects karri tree growth.

Summary of progress and main findings

- Survey of the Warren Thinning Trial, 20 yrs after thinning, was completed in April 2006.
- Stump pulling as a control measure has been undertaken in Warren block.
- Scientific paper published: Robinson, R.M. (2005) Volume loss in thinned karri regrowth infected by *Armillaria luteobubalina* in Western Australia. Proceedings of the 11th IUFRO International Conference on Root and Butt Rots of Forest Trees. Poznań and Białowieża, Poland, 16-22 August 2004).
- Poster prepared: Robinson, R.M. and Seymour, A. (2004). Stump Pulling to Control Armillaria Root Disease Following the First Thinning of Regrowth Karri. Research Working Group 7 (Forest Health) Biennial Meeting, Karri Valley, Pemberton, 25-28th August, 2004.
- Six long-term monitoring plots were established in Warren block.

Management implications

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

Future directions (next 12-18 months)

- Analyse data from the Warren Thinning Trial to determine the effects of thinning after 20 yrs.
- Long-term monitoring plots to be assessed every 5 years in Warren block.

DEC Region
Warren.

IBRA Region
Warren.

NRM Region
South West.

The effect of wildfire on fungi

SPP # 98/0015

Team members
R Robinson (0.1), J Fielder (0.1): Total (0.2).

Context
Fungi are amongst the most important of forest organisms in terms of their biodiversity and ecosystem functions. They play key roles in decomposition and nutrient cycling, enhance soil structure and nutrient uptake by plants, and provide food for native mammals. Fire impacts significantly on the physical environment in which fungi persist. By monitoring the presence of fungal fruit bodies on burnt sites over time, changes in species composition and abundance can be determined. The results can be included in the forest management when making decisions on appropriate fire regimes for the maintenance of biodiversity.

It aligns with Corporate Priorities 1, 3, 8, 10 and 12, and KRA 3, sub-outputs NC 3C and 3K and SFM 3A and 3D.

Aims

- To investigate the effects of wildfire on fungi in karri forest.
- To monitor the succession of fungi on burnt sites in karri forest.

Summary of progress and main findings

- Fieldwork for the first 5 yrs after fire has been completed, and a 10 year post-fire assessment is

currently underway.

- Annual reports prepared (1998, 1999, 2000).
- Results show that many species of fungi respond directly to fire or are associated with the post-fire conditions in karri forest. Fungal community structure differs significantly for each year following fire for at least 5 yrs. Fire mosaics have the potential to enhance fungal diversity across a landscape.
- Scientific paper accepted for publication in *Austral Ecology*: Robinson, RM, Mellican, A and Smith, RH. The succession of macrofungi following a wildfire in karri regrowth forests in Western Australia.
- Scientific paper accepted for publication in Conservation Science. Robinson, RM and Tunsell, VL. Preliminary list of macrofungi recorded in burnt and unburnt *Eucalyptus diversicolor* regrowth forest in the south-west of Western Australia: 1998-2002. Conservation Science.
- Scientific paper published. 2006 Robinson, R.M. 2006. Varying fire regimes to promote fungal diversity across the landscape. Australasian Plant Conservation 14: 16-17.

Management implications

- Results contribute to information on the management of fire for enhancing biodiversity in eucalypt forest.

Future directions (next 12-18 months)

- Ten year post-fire survey to be completed by December 2000, and data analyzed.
- Laboratory work continues to catalogue and identify voucher specimens collected throughout the project.
- Collaborate with colleagues from other agencies with identification of voucher specimens.

DEC Region
Warren.

IBRA Region
Warren.

NRM Region
South West.

Forest health and vitality surveillance and monitoring

SPP # not yet allocated

Team members
R Robinson (0.15), J Farr (0.15); Total (0.30).

Context
Key Performance Indicator 17 of the Forest Management Plan requires that DEC report on the severity status of weeds and pests, and investigate the cause of any increase in severity status as a result of management actions. This forms part of the adaptive management process. DEC requires a structured approach to monitoring to identify significant weeds, diseases and pests and track their status over time.

This project directly addresses Corporate sub-output SFM 3K.

Aim
To devise, establish and implement a Forest Health Surveillance (FHS) system for Western Australian forests.

Summary of progress and main findings.

- An options paper has been prepared and submitted to Sustainable Forest Management Division for consideration.
- A working group comprising representatives from Divisions of Sustainable Forest Management Division, Regional Services, Nature Conservation and Science will be tasked with developing an implementation plan.

Management implications

- None to date.

Future directions (next 12-18 months)

- The FHS system will be administered and implemented by Sustainable Forest Management Division and Regional Services Division with advice and input from Science Division.
- Confirm sampling strategies and methodology for FHS.
- Develop an implementation plan for FHS.

DEC Regions
South West, Swan, Warren.

IBRA Regions
Jarrah Forest, Warren.

NRM Regions
South Coast, South West.

Aspects of dieback behaviour relevant to the formulation of jarrah silviculture guidelines

SPP # not yet allocated

Team member
M Stukely (0.5).

Context
Jarrah stands are managed in accordance with silvicultural guidelines (SFM Guideline No.1) to promote the growth of crop trees for timber production and to conserve other forest values. The presence of the pathogen *Phytophthora cinnamomi* requires implementation of appropriate measures to minimize the impact of *Phytophthora* Dieback disease on the forest and the consequent reduction in its productivity and ecological integrity. On sites where disease impact is predicted to be moderate to high the silvicultural operation termed 'Selective cut in dieback' is in general use. A number of key assumptions underpin the jarrah Silvicultural Guidelines.

The project aligns with Corporate Priorities 9 and 12, KRA 3 and sub-outputs SFM 3A, 3M and NC 3L.

Aim

The 2 key aims of the project are to develop a sound, scientifically based understanding of:

- The effect of current silvicultural treatments on dieback expression.
- The effect of alternative approaches to silvicultural treatments on dieback expression.

Secondary aims of the project will include investigating:

- The effect of retained over-storey in relation to dieback impact escalation.
- The occurrence and persistence of jarrah regeneration [and key tolerant species] in the presence of *Phytophthora cinnamomi* on different sites.

Summary of progress and main findings

- Concept Plan approved.
- SPP submitted for approval following discussions with SFM staff.

Management implications

- The project will provide scientific data and conclusions relating to key assumptions that underpin the DEC Jarrah Silviculture Guidelines, as contained in *Silvicultural Practice in the Jarrah Forest* (SFM Guideline No.1, 2004). The findings will be relevant primarily to jarrah forest areas that are managed in the presence of *Phytophthora* Dieback for timber production, and some key elements will also apply to management for nature conservation values.
- The information gained will be used in supporting, or modifying and updating, the Guidelines, depending on operational priorities. The project will contribute to the provision of a clearer scientific basis for the adaptive management of jarrah forest in the presence of *Phytophthora* Dieback.

Future directions (next 12-18 months)

- Select site and set up a fully replicated Pilot trial; carry out initial assessments and measurements; analyse data and modify design as necessary.
- Commence site selection and establishment of trials at different sites, and carry out initial assessments and measurements.

DEC Region
South West, Swan.

IBRA Region
Jarrah Forest.

NRM Region
South West, Swan.

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
P Van Heurck (0.1), I Abbott (0.02), A Mellican (0.02); district staff - E Middleton; Walpole-Nornalup Parks Association and Walpole community volunteers; Total (0.14).

Context
The tall wet tingle and karri forests contain a high proportion of short range relict invertebrate species. In March 2001 a wildfire in the Nuyts Wilderness forests provided an opportunity to assess the impact of a high intensity wildfire on the species composition of these relict invertebrate communities. Species composition was also compared with relict invertebrate communities in prescribed burnt and long unburnt tall wet forests. Understanding effects of a single intense wildfire on invertebrate biodiversity is important for developing and implementing ecologically appropriate fire regimes and for managing fire for the protection of life and property. This study, established in December 2001, was designed to involve and educate the local volunteers in the establishment of a long-term invertebrate collection.

It aligns with Corporate Priorities 1, 3, 6, 8 and 10 and KRA 1, 2, 3 and 6 and sub-outputs NC 2B, 3B, 3K and 6A and PVS 2A and 6B).

Aim

To describe 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 December 2001.
- December 2004 and April 2005 yearly site trapping complete.
- Local curator Jember Manning and trained volunteers sorted and incorporated over 1 000 morphospecies into the Nuyts Collection. There are now 6580 specimens in the collection.
- Nature photographer D Annison was sub-contracted to develop a coloured digital microphotography manual.
- Workshop by D Annison to train volunteers in the use of new digital camera, microscope, and Auto-montage software.
- High resolution photography of 250 identified beetle species completed. C Steele is currently photographing ants, spiders and other taxa.
- G Muir (Walpole Wilderness Eco-cruises) managed the setup of website (http://www.lukasrinnhofer.at/wow2/), access database, and incorporation of first beetle images.
- Funding provided to WA Museum for taxonomists to identify arachnid and millipede taxa.
- Funding provided to Curtin University for a taxonomist to identify ant and wasp taxa and employ a zoological illustrator to complete the illustrations for a key to south-west ant species.
- A *Landscope 21(1)* article on the role of the local volunteers in this project published is in spring 2005.
- A handbook by Manning, Jacqueline (2006) 'Beetles of the Walpole-Nornalup National Park' was published.
- T Havik a scientific illustrator from the Netherlands is currently preparing drawings of the new species found.

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 310 beetle species collected to date 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 are thought to represent c. 20% of biodiversity. The Nuyts beetles probably represent a significant 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.
- Due to the training of volunteers in biosurvey techniques, from the Walpole-Nornalup National Parks Association and the Walpole community, it has been possible to sort large numbers of specimens collected over the last 4 yrs. 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. Highly skilled volunteers are available to effectively train other staff in future biosurvey projects.
- The provision of high resolution morphospecies images on the website for the use of international taxonomists will facilitate rapid identification of reference collection morphospecies. This integrated approach may provide a model suited to broader use by local communities working in partnership with scientists and land managers.

Future directions (next 12-18 months)

- Provide information to the local community via the Walpole Wilderness Invertebrate website, Discovery Centre displays and talks.

- Provide ecological information to local tour guides and operators.
- Educate and attract eco-tourists.
- Make available the species collection of an entire litter community for the use of local and international taxonomic specialists.
- Provide the database, reports and recommendations to fire managers and planners of old growth forest parks.
- Publish aspects of this project as a comparative study of para-taxonomy training by local volunteers.

DEC Region
Warren.

IBRA Region
Warren.

NRM Regions
South Coast, South West.

Effects of timber harvesting on terrestrial vertebrates in medium rainfall jarrah forest
SPP # 93/0115

Team members
A Wayne (0.1), C Ward (0.1), C Vellios (0.1), M Maxwell (0.1); Total FTE: 0.4.

Context
Understanding the impacts of timber harvesting on the terrestrial vertebrates of the jarrah forest is necessary for biodiversity conservation and the development of ecologically sustainable forest management practices. Data collection at the field sites was conducted in 2004/05 to support data collected 1994-2000.

This study aligns with Corporate Priorities 3, 10 and 12, and aligns with Key Result Areas 2.2, 3.8, and 4.3.

Aims
- To investigate the impacts of current silvicultural practices on jarrah forest ecosystems.
- To determine what factors contribute to observed impacts.
- To develop or modify silvicultural prescriptions to ensure the ecologically sustainable management of timber harvesting in the jarrah forest.

Summary of progress
- Spotlight monitoring on the 3 standardized transects was maintained at 6 repeat surveys per transect per year.
- Data collation and validation for trapping and spotlighting is complete and up-to-date.
- Data analysis is underway in preparation for the publication of medium-sized mammal responses to timber harvesting.

Management implications
- Improve ecologically sustainable forest management practices and the conservation of biodiversity.
- Improve efficiency of methods used for fauna monitoring (e.g. Western Shield) and research based on the findings submitted for publication on the factors affecting the detection of possums by spotlighting.

Future directions (next 12-18 months)

- Analyse and publish the findings of immediate and short-term responses of medium-sized mammals to jarrah forest timber harvesting, based on trapping data.
- Analyse and publish the findings of the abundance of possums over time based on spotlight monitoring data.

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

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), Technical officer (0.1); Total (0.3).

Context
Hollow bearing trees and logs are elements of forest structure that are essential for the conservation of hollow dependant birds and mammals. The knowledge gained from studying the availability of these hollows and identifying the attributes of trees and logs that bear hollows improves DEC's ability to manage for this aspect of ecological sustainable forest management. This study, which is largely complete, is currently focusing on hollows in logs on the ground.

This study aligns with Corporate Priority 9, and KRA 3. The study of logs on the forest floor will contribute to sub-output SFM 3I.

Aims

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

- To examine the relationship between burning history and the abundance of hollows and logs in various forest types.
- To examine the potential for modeling of recruitment, decay and removal of logs from the forest floor.
- To identify the types and sizes of log hollow that are likely to be used by hollow dependent fauna in the jarrah forest.
- To determine the density of log hollows required by various hollow dependent fauna in the jarrah forest.

Summary of progress and main findings

- Five papers in scientific journals, one book chapter and a *Landscope* article have been published from this research.
- Completed measurement of hollows and ground logs on plots at 2 sites jarrah forest that have never been logged.
- Data from these ground log plots has been entered and processed.

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 directions (next 12-18 months)

- Establish and measure additional plots in jarrah forest sites that have never been logged to extend the data on the availability of hollows and logs on the forest floor.
- Analyse the data from ground log plots.

DEC Regions
South West, Warren.

IBRA Region
Jarrah Forest.

NRM Regions
South West, Swan.

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

SPP # 1999/021

Team member
K Whitford (0.4).

Context
Timber harvesting and forest management activities impact on soil physical and chemical properties. This study evaluated indicators of soil physical and chemical status, and contributed to the development of standards for soil management during timber harvesting activities in the jarrah and karri forests.

This study contributes directly to Corporate Priority 9, KRA 3 and specifically sub-outputs SFM 3C, SFM 3E and SFM 3N.

Aims

- To investigate the use of soil organic matter as an indicator of ecologically sustainable forest management in the jarrah and karri forests.
- To examine the impact of fire on organic C and N in the jarrah and karri forest.
- To develop and refine the survey techniques proposed in the nationally agreed survey protocol for estimating soil disturbance.
- To establish base data on the intensity and extent of soil disturbance in jarrah harvesting coupes.
- To develop appropriate techniques for measuring bulk density in gravelly forest soils, and examine the relationship between soil disturbance class, bulk density and soil shear strength.
- To compare techniques for measuring snig track area.
- To investigate the impact of snig track compaction on tree and stand growth in the karri forest.
- To assist with the development and application of soil disturbance monitoring and management system for the jarrah and karri forests.
- To provide a scientific basis for the soil disturbance monitoring and management system applied in the jarrah and karri forests.

Summary of progress and main findings

- The final report to the funding body has been submitted, and published on the Forest and Wood Products Research and Development Corporation's website.
- Three manuscripts from this work are being prepared for publication in scientific journals.
- Training in soil disturbance assessment was provided to Forest Management Branch staff, and FPC staff.
- Adaptive trials of cording were undertaken, reported on and presented at a DEC FPC and timber industry workshop.
- A report on these adaptive trials of cording is being prepared for publication in a scientific journal.

Management implications

- This work contributed to development and implementation of Appendix 6 of FMP 2004-2013.
- Advice was provided to the Forest Policy and Practices Branch of the Sustainable Forest Management Division for the development of the *Interim Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests*.
- Adaptive management trials were undertaken in conjunction with the timber industry and FPC to examine alternative approaches to managing soil disturbance to those proposed in the Forest Management Plan (2004-2013).
- Contributed to the review of the system used for the protection of soil in native forest harvesting, and the workshop on this review.

Future directions (next 12-18 months)

- Finalize the publication of manuscript on adaptive trials of cording.
- Revise and submit 3 manuscripts that have been prepared for publication.
- Continue to advise and assist where appropriate with the implementation of Appendix 6 of the FMP (2004-2013) and the development of the *Soil and Water Conservation Guidelines.*

DEC Regions

South West, Warren.

IBRA Regions

Jarrah Forest, Warren.

NRM Regions

South West, Swan.

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 (0.1).

Context

The availability of a seed crop of appropriate density is a fundamental requirement for the success of shelterwood regeneration following timber harvesting. This study has enabled more accurate specification and prediction of the seed available in stands that are to be harvested to shelterwood specifications.

This study aligns with Corporate Priority 9 and KRA 3.

Aims

- 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.
- To develop a method of estimating the existing seed crop of the trees in stand from field assessments of these trees.

Summary of progress and main findings

- Final SPP report completed.
- Manuscript prepared for scientific journal requires revision and preparation for publication.
- Fifteen jarrah trees were assessed, felled and stripped of seed to use in developing a relationship for predicting the existing seed crop based on the current attributes of the tree.

Management implications

- Results from this research have been used to revise 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 directions (next 12-18 months)

- Revise manuscript on jarrah seed fall and submit for publication in refereed journal.
- Continue to assist Jeff Cargill (PhD student, Edith Cowan University) in developing a tree based seed crop assessment procedure that can be readily applied in the field.
- Assess, fell and strip additional trees to use in developing a relationship for predicting the existing seed crop based on the current attributes of the tree.
- Prepare manuscript on the development of the tree based seed crop assessment procedure.
- Assist with and promote the application of this tree based seed crop assessment procedure in shelterwood silviculture.

DEC Regions

South West, Swan.

IBRA Region
Jarrah Forest.

NRM Regions
South West, Swan.

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

SPP # 93/97

Team members
A Wills (0.01), P Van Heurck (0.01), I Abbott (0.01); Total (0.03).

Context
Jarrah leafminer is an important pest species of jarrah, with significant effects on jarrah biomass production. Few management options are available to control jarrah leafminer (JLM). This trial represents on a small scale a possible remediation of the impact of leafminer through selective retention of resistant trees by appropriate silviculture during tree harvesting operations.

This JLM demonstration trial aligns with KRA 3.11 and 6.1 and sub-outputs SFM 3J and 6A.

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

Summary of progress and main findings

- Site inspected, maintenance depends on severity of leafminer for expression of resistance.

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 directions (next 12-18 months)

- Inspect site annually and carry out coppice removal on treated areas as required.

DEC Region
South West.

IBRA Region
Jarrah Forest.

NRM Region
South West.

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

SPP # 01/005

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

Context

It is important to understand the factors controlling the distribution of invertebrates in the jarrah forest landscape, and whether specialized or fire sensitive faunas that are restricted to particular geomorphic units are important for developing and implementing ecologically appropriate fire regimes and for managing fire for the protection of life and property.

This study aligns with KRA 3.8 and sub-outputs SFM 3A and 3D and NC 3K.

Aims

- 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

- Statistical ordination of ants, beetles and spiders completed. There are differences within and between catenas in ant, beetle and spider assemblages. Aspect is an important determinant of assemblages across geographical scales of several hundred metres.

Management implications

Incised valleys are important contributors to β and γ diversity of invertebrates. Management implications not yet apparent as analysis of data not completed.

Future directions (next 12-18 months)

- Update database and analyse the combined dataset.
- Write up and publish in refereed journal.

DEC Region

Swan.

IBRA Region

Jarrah Forest.

NRM Region

Swan.

Monitoring the northern extent of jarrah leafminer outbreak

SPP # not yet allocated

Team members

A Wills (0.02), P Van Heurck (0.01); Total (0.03).

Context

Jarrah leafminer is an important pest species of jarrah, with significant effects on jarrah biomass production. Monitoring the incursion of jarrah leafminer infestation into highly productive areas of jarrah informs management of those areas as a long – term demonstration of the absence of impact of standard management practices on the spread of infestation.

This monitoring program aligns with Objective18.4 and Key Performance Indicator 17 in the Forest Management Plan 2004-2013. JLM monitoring aligns with KRA 3.11 and sub-outputs SFM 3J and 3K.

Aims

- To monitor and document the northern extent of jarrah leafminer outbreak in jarrah forest.
- To provide warning of change in forest health and productivity caused by incursion of jarrah leafminer into as yet unaffected forest.

Summary of progress and main findings

- No action required. There have been no casual reports of progress northwards of JLM populations since the last survey in 2004.

Management implications

- Biomass productivity of jarrah in the northern jarrah forest is unaffected by jarrah leafminer.

Future directions (next 12-18 months)

- Continued monitoring of the outbreak at 5 yrly intervals is recommended, unless expansion of outbreak eventuates sooner. Next monitoring due 2009.

DEC Region
Swan.

IBRA Region
Jarrah Forest.

NRM Region
Swan.

Bushfire CRC Project B1.1: Managing fires in forested landscapes in south-west WA
SPP # 2007/003

Team members
R Wittkuhn (CRC-funded postdoctoral researcher) (1.0), L McCaw (0.2), R Robinson (0.2), J Farr (0.2), B Ward (0.1), G. Phelan (0.2), J. Fielder (0.1), G Liddelow (0.2), L Shu (0.1), F Metcalfe (0.2), C Carpenter (0.1), J. Hollis (0.3), P. Van Heurck (0.2); Total (3.1).

Context
Understanding long-term effects of fire on the floristics and structure of forested landscapes is important for developing and implementing ecologically appropriate fire regimes and for managing fire for the protection of life and property. This study incorporates the known fire history in the Frankland District (in the form of maps that date back to 1953) to establish survey plots that investigate the impact of fire history on diversity and abundance of flora, fauna, invertebrates and fungi.

It aligns with Corporate Priorities 10 and 12, KRA 2 and 3 and sub-output NC 3K.

Aim
To improve understanding of the ecological effects of fire at landscape scale by comparing the flora and fauna in forest areas that have experienced different fire regimes over the past 5 decades.

Summary of progress and main findings

- The experimental design for the project has been finalized – replicate sites with successive short fire intervals and areas with successive long fire intervals are being compared with areas that have a mixed fire interval regime.
- All monitoring grids are now established (30 plots).
- Invertebrate (beetle) surveys have been completed for spring 2006 and autumn 2007. Sorting of

specimens collected in the spring 2006 survey has been completed.

- Vertebrate fauna trapping (Sheffield and pitfall traps) has been completed for autumn 2007 and data entered.
- Fungi surveys have commenced (May-July 2007) and are being run over 2 weeks spaced one month apart to account for seasonal progression of fruiting species.
- Forest structure measurements have commenced (16 of the 30 plots require these measurements), and should be completed by the end of 2007.
- Relative measures of fire intensity between forest plots was completed by Ryan Burrows (University of Western Australia 3rd year student).
- Manuscript submitted to Proceedings of the Royal Society of Queensland on the GIS mapping of fire interval sequences. This forms the Proceedings of the Bushfire 2006 conference.

Management implications

- Provision of scientifically-based guidelines for the appropriate fire frequency in the southeastern jarrah forest to achieve a range of land management objectives.
- Development of protocols for the collection, digital capturing and attribution of fire information at the landscape and plot scale.

Future directions (next 12-18 months)

- Presentation of the research aims/objectives/anticipated outcomes at international Mediterranean Ecosystems (Medecos) conference in Perth Sept 3-6.
- Flora surveys (spring 2007 and 2008), and surveys for summer flowering species early 2008.
- Vertebrate fauna surveys in spring 2007 and autumn 2008.
- Invertebrate surveys in spring 2007 and autumn 2008,
- Fungi surveys in winter 2008.
- Completion of forest structure measurements (throughout 2007).
- Complete manuscripts on:
    - Design and construction of the fire history database.
    - Literature review on fire regime effects on biota.
    - Description of the fire history for the Warren Region.

DEC Region
Warren.

IBRA Region
Warren.

NRM Regions
South Coast, South West.

Fire, fragmentation, weeds and the conservation of plant diversity in wheatbelt Nature Reserves
SPP # not yet allocated

Team members
C Yates (0.10), C Gosper (1.0); Total (1.1).

Context
Application of an ecological approach to fire management in the conservation estate in the DEC Wheatbelt Region, encompassing some 612 nature reserves confronting multiple threatening processes is a significant operational and scientific challenge. Progress is being made in this area, but it is acknowledged that the lack of scientific information on fuel accumulation rates and fire

behaviour for major plant communities, and the relationships between fire and the biota in the region is a limiting factor.

Moreover, because many reserves are small (median size 116 ha) and isolated there are real concerns that prescribed fire regimes will act synergistically with other threatening processes, and have undesirable consequences for the native biota in the longer term. For example, some fire regimes may reduce the resistance of native plant communities to invasion by non-native annuals that are abundant in the surrounding landscape. Yet there is a danger that biodiversity will be lost regardless, because of a lack of any fire management.

This is a collaborative project funded by the Department of Environment and Conservation (DEC) and CSIRO Sustainable Ecosystems (CSE), and is part of the Saving our Species (SOS) program.

This study aligns with Corporate Priorities 3, 10, 12, KRA 2, KRA 3, and sub-outputs NC 2I, NC 3K.

Aim

- To investigate the following key questions related to the management of fire in Wheatbelt Nature Reserves:
- What are the current fire regimes experienced by remnants of native vegetation in the wheatbelt, and how do these relate to landscape context, such as remnant size, configuration and regional clearing history?
- What are the upper and lower limits of the temporal variability in fire regimes needed to maintain diversity in plant communities in vegetation remnants?
- How does fire and associated disturbances influence weed invasion in eastern wheatbelt plant communities?

Summary of progress and main findings

- The project commenced in February 2007.
- The study area has been identified, vegetation sampling plots have been established, and data collection has commenced.
- A detailed project plan is being developed.

Management implications

None to date.

- Future directions (next 12-18 months)
- Conduct floristic surveys to investigate changes in community composition and structure with time since fire in 2 example community types: mallee and Tallerack mallee-heath
- Investigate differences in fire regime with remnant size, landscape context and clearing history.
- Identify candidate species for use in case studies to study population demographic changes with time since fire.

DEC Region

Wheatbelt.

IBRA Regions

Mallee, Avon Wheatbelt, Esperance Plains.

NRM Regions

Avon, South Coast, Rangelands.

MARINE SCIENCE

Program Leader: Chris Simpson

Marine Science Program pamphlet

Core Function

Team members

C Simpson (0.01), S Long (0.01); Total (0.02).

Context

To ensure that Western Australia's marine biodiversity conservation program is based on sound science, a new Marine Science Program has been established within the Science Division of the Department of Environment and Conservation (DEC). This initiative, which complements DEC's extensive terrestrial science capacity, represents a significant increase in the capacity of DEC to provide a strong scientific foundation for the management of WA's world-class system of marine protected areas (MPAs) and for the conservation of the State's unique marine biodiversity.

A Marine Science Program pamphlet was produced and distributed to communicate information about the program's inception, aims and activities to the broader marine science community in Western Australia and nationally.

Aligns with Corporate Priorities 2006-2007: 1-3, 5-8, 11-12. KRAs NC 1,-4; 6, PVS 1A, 1C, 2A.

Aim

- To develop a communication tool to inform the Western Australian and the Commonwealth marine research community of the establishment of the program and the primary focus of the program's activities.

Summary of progress and main findings

- Marine Science Program pamphlet completed.
- Pamphlet posted on DEC website (NatureBase).
- Distributed widely to internal and external stakeholders.
- Article in 'Conservation News'.

Management implications

- Increased awareness of the activities of DEC's Marine Science Program has improved communications between MSP and other marine science providers/users in WA, thereby improving DEC's ability to adequately steward WA's marine environments.

DEC Regions

Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions

All State Marine Waters.

NRM Regions

Northern Agricultural, Rangelands, Swan, South West, South Coast.

Marine Science Strategy

Core Function

Team member
C Simpson (0.2).

Context
Marine science in Western Australia is in a period of rapid growth. Recent investment by the State Government, combined with co-investment from Commonwealth research agencies and local and interstate universities, will exceed $100M over the next 5 years. Much of this science is directly relevant to the objectives of the Department of Environment and Conservation (DEC). The Government has also substantially increased consolidated funding to implement the management plans of 'new' and existing marine protected areas, including significant specific allocations for marine research, monitoring and education/science communication.

A Marine Science Strategy has been developed at the request of the Director General of DEC.

Aligns with Corporate Priorities 2006-2007: 1-3, 5-8, 11-12. KRAs NC 1,-4; 6, PVS 1A, 1C, 2A,

Aim
To provide a broad blueprint for the development and implementation of a marine science capability within DEC over the next 5 years.

Summary of progress and main findings
- Coordinated a 'Marine Science Strategy' workshop on July 2006 DEC.
- Undertook a survey of NRM agencies in Australia in regards to meeting their marine science needs.
- Provided a Draft MSP Strategic Plan to the Director General in Jan 2007.
- Provided a Draft to all DEC Regional managers and marine staff in May 2007.
- Presented the Marine Science Strategy to the DEC Director of Science.
- Presented the Marine Science Strategy to the Marine Parks and Reserves Authority.
- Presented the Marine Science Strategy to the Western Australian Marine Science Institute.
- Presented the Marine Science Strategy to the Australasian Marine Science Association (WA) at the young marine scientists workshop held at Rottnest Island.
- Presented the Marine Science Strategy to the Executive Director of the Great Barrier Reef Marine Park Authority and the DEC Marine Policy and Planning Branch.

Management implications
- Provides staff profiles and FTE allocations across the research, monitoring, science communications and policy/advice functions, budget considerations and details of the specific objectives, tasks, outputs and expected outcomes of the proposed research, monitoring and science communication units.
- Resulted in a workshop at AMSA conference to be held in Melbourne in July 2007 to discuss interstate collaboration in marine parks science.

Future directions (next 12-18 months)
- Corporate Executive endorsement for the Marine Science Strategy.
- Director General endorsement for the Marine Science Strategy.

DEC Regions
Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions
All State Marine Waters.
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NRM Regions
Northern Agricultural, Rangelands, Swan, South West, South Coast.

Marine Science Business Plan: July 2007-2010
Core Function

Team member
C Simpson (0.1).

Context
In mid-2006, the Director General of the Department of Conservation and Environment (DEC) directed the Leader, Marine Science Program (MSP), a newly-formed Program in the Department's Science Division, to develop a Marine Science Strategy (MSS) to guide the development of a marine science capacity in DEC to support the department's marine policy, planning and operational management responsibilities. The draft MMS was provided to the Director General for consideration in January 2007. Following consideration of the MSS, the Director General indicated *in principle* support for the MSS and then directed that a plan be developed to outline a specific forward program of activities to be undertaken over the next 2 to 3 years.

The MSBP has been developed in collaboration with DEC regions and specialist branches.

Aligns with Corporate Priorities 2006-2007: 1-3, 5-8, 11-12. KRAs NC 1,-4; 6, PVS 1A, 1C, 2A,

Aim

- To provide a framework that outlines the marine science activities to be undertaken in 2007/08 and future priorities to be addressed beyond 2007/08.

Summary of progress and main findings

- Marine Science Strategy developed.
- Marine Science Strategy distributed for comment to DEC Regional Managers and managers of specialist branches in May 2007.

Management implications

- N/A.

Future directions (next 12-18 months)

- Corporate Executive endorsement for the Marine Science Business Plan.
- Consult with and reach agreement with Regional Managers on collaborative arrangements.
- Finalize MOUs with Regions and Specialist Branches (re: above dot point).
- Consultation on marine Science Strategy and Marine Science Business Plan with external marine science stakeholders.
- Develop JDFs, advertise and appoint MSP-funded positions.
- Develop JDFs, advertise and appoint non-MSP funded positions.
- Develop Marine Planning Research Strategy and forward to DEC Corporate Executive for consideration and endorsement.
- Develop Marine Biodiversity Survey Strategy and forward to DEC Corporate Executive for consideration and endorsement.
- Develop Marine Environmental Protection Research Strategy and forward to DEC Corporate Executive for consideration and endorsement.
- Review marine Science Business Plan for 2008/09 and 2009/10 in light of the above.

DEC Regions
Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions
All State Marine Waters.

NRM Regions
Northern Agricultural, Rangelands, Swan, South West, South Coast.

Fishing compliance in Western Australian marine protected areas: The interaction between compliance and science: A discussion paper
Core Function - Policy

Team member
C Simpson (0.03).

Context
The State Government has recently allocated significant funding to the Department of Fisheries for compliance in Western Australia's system of marine protected areas. This funding was provided to increase compliance effort, particularly on zones that wholly or significantly restrict fishing. At the same time, the State Government has provided significant marine science funding to investigate the efficacy of these 'no take' zones for marine biodiversity conservation and the management of fishing in marine protected areas. Effective compliance programs are essential for the correct interpretation of these research and monitoring investigations.

Measuring the effectiveness of compliance programs is inherently difficult. It is not surprising then that existing marine protected area compliance programs currently do not provide adequate measures to assess their effectiveness, particularly in relation to the level of fishing induced mortality of fish within zones that wholly or significantly restrict fishing. However, this deficiency will potentially result in difficulty in interpreting the results of scientific investigations, diminished biodiversity outcomes, wasted resources and more rather than less conflict between stakeholders in investigating one of the most contentious issues in marine natural resources management in Western Australia.

Aligns with Corporate Priorities 2006-2007: 3, 12 KRAs NC 2B, 2E-2G, 2I, 2J; PVS 2A.

Aim
- To draw attention to the critical interaction between compliance and marine science programs in Western Australian marine protected areas.
- To facilitate discussion and resolution of this important issue.

Summary of progress and main findings
- Circulated the discussion paper to DoF, MPPB and regions; discussions with DoF.
- Decision moved to form WG.

Management implications
- Improved compliance programs for 2007/08

Future directions (next 12-18 months)
- Monitoring of marine park zone (fisheries) compliance programs such that they are in accordance with the current MOU between DEC and DoF.

DEC Regions
Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions
All State Marine Waters.

NRM Regions
Northern Agricultural, Rangelands, Swan, South West, South Coast.

Establishing a long-term benthic community monitoring program in the Montebello/ Barrow Islands marine protected areas

SPP # not yet allocated

Team members
K Bancroft (0.4), S Long (0.1), S Armstrong (0.1), C Simpson (0.05), P Van Schoubroeck (0,05); Total Science Division (0.7). A Kendrick (0.1), R Connell (0.1) Total Pilbara Region (0.2). C Wadley (0.15); Total Dept of Fisheries (0.15).

Context
The Montebello/Barrow Islands marine protected areas (MBIMPA) which incorporates the Montebello Islands Marine Park, Barrow Island Marine Park and the Barrow Island Marine Management Area, were gazetted in 2005 and are vested in the Marine Parks and Reserves Authority (MPRA). The WA Department of Environment and Conservation (DEC), in collaboration with the Department of Fisheries (DoF), are responsible for the progressive implementation of the reserves' management plan on behalf of the MPRA.

The DEC's Marine Science Program, in collaboration with the Pilbara Region, is establishing a long-term monitoring program in the MBIMPA. This program is a requirement of the management plan (Department of Environment and Conservation and the Marine Parks and Reserves Authority 2004) and will, ultimately, provide time-series data on the condition and pressure(s) of the ecological values and the effectiveness of management actions. This information is necessary for the conservation and maintenance of the ecological and social values of the reserves and the management of human use in the area.

Aligns with Corporate Priorities 2006-2007: 2, 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J, 3C; PVS 2A,

Aim
To establish a network of long-term monitoring sites for the major benthic communities of the MBIMPA. The major activity for 2006-2007 was to establish a network of long-term coral reef monitoring sites in the MBIMPA.

Summary of progress and main findings
- Field Program Report (August) completed and distributed.
- Scoping field survey undertaken.
- Data report (August) completed and distributed.
- Field Program Report (December) completed and distributed.
- Field survey undertaken.
- Established 26 long-term monitoring sites for coral communities.
- Draft Data Report (December) completed.
- Scientific note submitted to '*Coral Reefs*' re: coral reef complex.
- Released media statement (August survey).
- Released media statement (December survey).

Management implications

- Provided a media quality DVD to Strategic Development and Corporate Affairs for Communication & education usage.
- Media quality tape of bommie fields and Dugong Reef provided to the ABC for their file footage library.
- Provided video clip of coral reef footage to Environmental Protection Authority re: Gorgon assessment.
- Provided advice to MPRA re: humpback whale entrapment in pearling lease in Montebello Is.
- Developed an Operational Guideline: Recommendations for the conservation of *Scylla* spp. in the Montebello/Barrow Islands Marine Protected Areas.

Future directions (next 12-18 months)

- A new study 'Developing a better understanding of the distributions and patterns of the major benthic communities of the Montebello/Barrow Islands marine protected areas' to commence in 2007/08 for 3 years.

DEC Region
Pilbara.

IMCRA Region
Pilbara (nearshore).

NRM Region
Rangelands.

Rowley Shoals Marine Park Marine Research and Monitoring Projects Database
SPP # not yet allocated

Team members
K Bancroft (0.10), S Long (0.02), A Edwards (0.15); Total (0.27)

Context
The Rowley Shoals are made up of 3 isolated shelf atolls (Mermaid, Imperieuse and Clerke Reefs) off the north-western Australian coast, approximately 260 km west of Broome (Department of Environment and Conservation and Marine Parks and Reserves Authority 2007). In 1990 Imperieuse and Clerke reef formed the Rowley Shoals Marine Park (RSMP), which has recently been extended in the Rowley Shoals Marine Park Management Plan 2007-2017 (Department of Environment and Conservation and Marine Parks and Reserves Authority 2007). The Mermaid Reef Marine National Nature Reserve (MRMNNR) was established by the Commonwealth government in 1991, and is managed by the Department of Environment and Conservation (DEC) under a Memorandum of Understanding with the Department of Environment and Water Resources. Due to the remoteness of these reefs, they have been largely unstudied by marine scientists in the past. However, in recent times, the relatively unimpacted nature of this area has brought new found interest from a variety of researchers.

This project will develop a comprehensive list of references, including published and unpublished literature, and a comprehensive list of all the current and proposed marine research projects, relevant to the conservation of the RSMP and MRMNNR. This information given will be used to identify gaps in knowledge and information regarding the management of the Rowley Shoals Marine Park and the Mermaid Reef Marine National Nature Reserve. Focus will be made on addressing those gaps in future research and monitoring programs.

The compilation of the bibliography and the list of current and proposed research projects relevant to the RSMP and MRMNNR, address high priority management strategies within the RSMP management plan (Department of Environment and Conservation, 2007) to '*develop and maintain a database of historical and current research in the reserves*', to '*develop and progressively implement a coordinated and coordinated research program focused on key values and processes of the park'* and to '*identify, prioritize and communicate high priority ecological and social research projects relevant to management of the park…'* and the MRMNNR plan of management (Environment Australia, 2000) to *'develop research and monitoring programs that will provide information for management*'.

Aligns with Corporate Priorities 2006-2007: 3, 11, 12. KRAs NC 2B, 2F, 2G, 2I, 2J, 3C;

Aim

- To develop a comprehensive list of references, including published and unpublished literature, relevant to the conservation of the RSMP and MRMNNR.
- To develop a comprehensive list of all the current and proposed marine research projects relevant to the conservation of the RSMP and the MRMNNR.

Summary of progress and main findings

- Compiled a comprehensive list of references, including published and unpublished literature relevant to the conservation of the RSMP and MRMNNR, as of June 2007.
- Completed a report (Bibliography of historical research and monitoring).
- Compiled a comprehensive list of all the current and proposed marine research projects, relevant to the conservation of the RSMP and MRMNNR.
- Completed a report (Current and proposed marine research and monitoring projects).

Management implications

- These data are necessary for the identification of gaps in knowledge and information regarding the management of the RSMP and the MRMNNR. Future research and monitoring programs will address these gaps.

Future directions (next 12-18 months)

- A major collaborative survey with AIMS and West Kimberley District, is planned to be undertaken by November 2007.

DEC Region
Kimberley.

IMCRA Region
Oceanic Shoals.

NRM Region
Rangelands.

Metropolitan Marine Parks Marine Research and Monitoring Projects Database
SPP # not yet allocated

Team members
K Bancroft (0.05); Total Science Division (0.10). D Lierich (0.19), K Fitzgerald (0.05), J Edwards (0.01); Total Swan Region (0.25).

Context
In the Perth metropolitan region, there are several marine parks and island nature reserves vested to the Marine Parks and Reserves Authority and the Conservation Commission of Western Australia, respectively. These are: Marmion Marine Park (MMP), the Swan Estuary Marine Park (SEMP), the Shoalwater Islands Marine Park (SIMP), the Carnac Island Nature Reserve, the Penguin Island Conservation Park and the Seal Island Nature Reserve. Due to their close proximity to the high population centre of Perth, they are under constant pressure from human activities such as wastewater discharges, recreational fishing, commercial fishing, reef walking, scuba diving, kayaking, surfing and tourism. This provides an opportunity for the Perth metropolitan marine environment to be an important place for scientific research and marine educational purposes.

With 4 universities in Perth specializing in a variety of disciplines of marine science and with the ease of accessibility to these significant marine environments, there has been a great deal of marine scientific research conducted in the metropolitan area. Another contributing factor to the substantial marine research conducted in the area is the responsibility of industry and government agencies to continually monitor the marine environment for signs of degradation and to provide offsets to their impacts (e.g. seagrass transplant research).

This study will develop a bibliography of reports and papers derived from historical marine scientific research and compile a list all current and proposed scientific research relevant to the metropolitan marine parks and adjacent waters. Collectively, these data address high priority management strategies within the SIMP draft management plan (Department of Environment and Conservation 2006) to '*develop and maintain a database of historical and current research in the park*', to '*develop and progressively implement a coordinated and coordinated research program focused on key values and processes of the park'* and to '*identify, prioritize and communicate high priority ecological and social research projects relevant to management of the park…'.* Even though the collation of information for this study is not explicit in the SEMP, MMP and Carnac Island management plans (Department of Conservation and Land Management 1992; 1999a; 2003), it is fundamental to the identification of gaps in knowledge; avoiding duplication of research and monitoring, and prioritizing future research for Perth's metropolitan marine parks.

Aligns with Corporate Priorities 2006-2007: 3, 11, 12. KRAs NC 2B, 2F, 2G, 2I, 2J, 3C;

Aim

- To develop a comprehensive list of references, including published and unpublished literature, relevant to the conservation of the metropolitan marine parks.
- To develop a comprehensive list of all the current and proposed marine research projects relevant to the conservation of the metropolitan marine parks.

Summary of progress and main findings

- Completed a report (Bibliography of historical research and monitoring).
- Completed a report (Current and proposed marine research and monitoring projects).

Management implications

- These data are necessary for the identification of gaps in knowledge and information regarding the management of the MMP, SEMP and SIMP. Future research and monitoring programs will address these gaps.

Future directions (next 12-18 months)

- Initiation of annual monitoring of KPIs and SZ effectiveness in the metro MPAs in 2007/08.

DEC Region
Swan.

IMCRA Region
Central West Coast.

NRM Region
Swan.

Coral Bay coral communities recovery survey 2006

SPP # not yet allocated

Team members
S Long (0.1), S Armstrong (0.05), C Simpson (0.05); Total Science Division (0.2). Total Pilbara Region (0.05).

Context
The 2006 survey of Bill's Bay has contributed to a comprehensive dataset describing coral community structure in this heavily visited area of Ningaloo Marine Park, including patterns of recovery since a natural mass mortality event in 1989. Comprised of information collected over 17 years by DEC (CALM), AIMS and university researchers, this dataset is being compiled and analyzed to produce a detailed quantitative description of the responses of these coral communities to disturbance over time. Such a long-term dataset is rare for coral reef environments, and it will become an increasingly valuable resource both for management of Ningaloo Reef, and also for international research programs investigating coral reef resilience and recovery.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J.

Aim
- To quantify benthic community structure at the 17 DEC sites in Bill's Bay.
- To measure size and frequency of juvenile coral colonies at selected sites (representing inner, middle and outer zones of Bill's Bay) and to identify to taxonomic family where possible

Summary of progress and main findings
- Outer reefs have been stable during the period of observation (17 years), while inner reefs are recovering from mass mortality events.
- Field Program Report and field work completed.
- Data Report completed.
- Scientific paper submitted to international peer-reviewed scientific journal '*Coral Reefs*' where it is currently under review.
- Scientific paper describing recovery of reef communities in preparation, in collaboration with scientists at the Australian Institute of Marine Science.
- Incorporation of data into DIVE, the CSIRO-designed data visualization platform that is being trialled as a tool by WAMSI and for adaptive management of marine parks in WA.
- Regional radio interview during field survey (ABC Karratha).
- Formal presentation of preliminary results to community and local DEC staff in Coral Bay.

Management implications
- Appropriate management can facilitate recovery of reefs from disturbances such as mass mortality events. Vulnerable reefs need to be protected from anthropogenic disturbances.

Future directions (next 12-18 months)
- Building on this extraordinarily valuable dataset, the sites will be resurveyed every 3 years.
- Present results at the WAMSI Ningaloo Symposium in July 2007 and the Australian Coral Reef Society's annual meeting in October 2007.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Coral spawning observations: Coral Bay April 2007
SPP # not yet allocated

Team members
S Long (0.05), C Simpson (0.03); Total (0.08).

Context
The annual coral spawning event in Coral Bay is unusual worldwide in that it is both highly predictable and relatively easy to access. Each year, the Marine Science Program intends to take advantage of the event as both a mechanism for increasing public awareness of WA's marine environment (education/communication) and for research.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J;

Aim
- To observe the 2007 coral spawning event while simultaneously providing opportunities for related public education and communication.

Summary of progress and main findings
- Primetime television coverage via a story on ABC's Stateline which aired on 13 April 2007.
- Underwater videography of spawning event, professionally edited into a short DEC-owned film which is publicly available via YouTube (http://www.youtube.com/MarineScienceWA).
- Provided scientific advice to DEC and Dept of Planning and Infrastructure staff and contractors re siltation of corals during construction of small boat facility at Moncks Head.
- Presented summary of MSP research activities at community workshop

Management implications
- Increased public awareness and appreciation of the marine environment of Coral Bay.
- Increased support for local regional DEC staff from the Marine Science Program.
- Addition to coral spawning phenological knowledge that will be useful for future management of the marine park.

Future directions (next 12-18 months)
- Annual coral spawning observations will be made and opportunities will be generated to piggyback small research projects or science communication/education activities.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Comparative marine biodiversity survey of the Rowley Shoals

SPP # not yet allocated

Team members
S Long (0.20), C Simpson (0.01), K Bancroft (0.07); Total (0.28).

Context
Due to their isolation and protection from most human impacts, the Rowley Shoals are likely to be amongst the most pristine coral reef environments remaining in the world. As coral reefs continue to degrade worldwide, careful management of the Rowley Shoals will be required to establish and maintain them as regional and potentially global benchmarks for coral reefs biodiversity conservation.

Successful management requires informed decision-making. Information about trends in marine biodiversity over time is essential for assessment of effectiveness of the different management regimes in effect (or shortly to be in effect) across the 3 shoals. Monitoring of human impacts as manifested in changes in marine biodiversity over time will facilitate best possible management of the Rowley Shoals.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J;

Summary of progress and main findings
- Prospectus (Concept Plan) completed and distributed to potential collaborators.
- Draft SPP prepared.
- Draft media statement prepared.

Management implications
- Media release announcing that survey will take place, timed to coincide with gazetting of zones in RSMP.

Future directions (next 12-18 months)
- A major collaborative survey with AIMS and West Kimberley District will occur in November 2007.

DEC Region
Kimberley.

IMCRA Region
Oceanic Shoals.

NRM Region
Rangelands.

Marine image library edition 1.0

Core function - communication

Team members
S Long (0.03), A Edwards (0.10), S Armstrong (0.01), K Bancroft (0.01), P Van Schoubroeck (0.05); Total (0.20).

Context

Effective communication of the Program's marine planning, management, research and monitoring activities is a high priority if we are to build a public constituency for marine conservation. A good way to attract public attention is through the use of high quality photographic imagery. To facilitate this, an electronic library of high-quality, media-ready, keyword-searchable, digital images has been constructed, containing only images that are available for free DEC use (i.e. without copyright or payment issues). At regular intervals this library will be updated and forwarded on disc to other groups in DEC (e.g. SDCA, regions) for use in their education and communication products.

Aim

- To develop an easily searchable database of high-quality images of marine biota, seascapes and human usage for marine education and communication, and make the images and database accessible to the people in DEC who need them.

Summary of progress and main findings

- Developed keyword-searchable database of images relevant to marine science in WA, edition 1.0.
- Provided images from the database for NatureBase website.
- Images have also been used already by SDCA for several applications including the 2008 Landscope calendar.

Management implications

- Improvement in the impact of DEC marine communication/education products.
- Savings in time and money due to availability of free, high quality, appropriate images.

Future directions (next 12-18 months)

- Ongoing production of high quality images of WA's marine environment, and incorporation into future editions of the Marine Image Library.

DEC Region

Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions

All State Marine Waters.

NRM Region

Northern Agricultural, Rangelands, Swan, South West, South Coast.

Disturbance history of coral reef communities in Bill's Bay, Ningaloo Marine Park, 1975-2007

SPP # not yet allocated

Team members

S Long (0.1), P Van Schoubroeck (0.15), S Armstrong (0.07), C Simpson (0.02); Total (0.34).

Context

Large gaps in our understanding of the disturbance history of Bill's Bay (Coral Bay, Western Australia) are hampering interpretation of a long-term dataset describing changes in coral communities over time in this popular and heavily-visited area of Ningaloo Marine Park (Long 2007). This study seeks to address this deficit by bringing together a number of data sources describing disturbances in Bill's Bay, from the 1975 cyclone event through to the present time (2007). The majority of this data concerns the more recent disturbance events. Some of these data have been sourced from members of the public who have an interest in conserving coral reef ecosystems and an understanding of the importance of recording significant events that impact on the ecosystem;

other data was collected on an opportunistic basis by government staff who happened to be on site at the time of the disturbance.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J.

Aim

- To collate the wide range of available coral community data for Bills Bay, Ningaloo Reef from a variety of isolated and unpublished sources.
- To synthesize data in order to better understand the geographical extent and ecological impact of these disturbances in Bill's Bay.

Summary of progress and main findings

- Report has been completed.

Management implications

- Report is being used to aid interpretation of scientific observations of coral reef disturbance and recovery in Bill's Bay.
- Process of collection of public data improved perceptions of DEC competence and relevance with respect to management of the marine park.

Future directions (next 12-18 months)

- Any future observations of disturbances to marine environments in Coral Bay will be noted and preserved for future scientific study.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Survey of *Drupella cornus* (coral eating marine snail) at Ningaloo Marine Park and Muiron Islands marine management area

SPP # not yet allocated

Team members

S Armstrong (0.35), S Long (0.06), K Bancroft (0.04), C Simpson (0.01), A Kendrick (0.06), R Mau (0.01), B Daw (0.01), H Dilley (0.02), S Gudge (0.02); Total DEC (0.58).

Context

Between the mid 1980s and early 1990s, the feeding activity of unusually high densities of the corallivorous gastropod *Drupella cornus* resulted in massive coral damage along at least 100 km of Ningaloo Marine Park (NMP), with coral mortality approaching 100% at some sites surveyed. To date, the density of *D. cornus*, the area and severity of associated coral damage and longevity of the 'outbreak' itself that occurred at NMP during this event was on a greater scale than recorded on reefs elsewhere in the world. As coral communities are a key performance indicator of management of NMP and the Muiron Islands Marine Management Area (MIMMA) it is essential to monitor spatial and temporal changes to *Drupella* densities and cover of associated corals in these conservation reserves. Adhering to this management need, DEC runs the Ningaloo Marine Park *Drupella* Long-term Monitoring Program (NMPDMP) which monitors long-term changes in the density of *Drupella* sp. and cover of associated benthic communities at the NMP and the MIMMA. With the southern extension of the NMP and gazettal of the MIMMA in 2004 came the need for these areas to be

represented in the NMPDMP. Therefore a survey was conducted in 2006 to establish and survey 6 new NMPDMP sites in the southern extension of the NMP and MIMMA and to re-survey 4 existing NMPDMP sites.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J.

Aim

- To determine the density of *Drupella* and percent cover of shallow-water benthic reef communities in the southern extension of the Ningaloo Marine Park and the Muiron Islands Marine Management Area.
- To assess the temporal comparability of the 2005 and 2006 *Drupella* survey data.
- To assess the statistical comparability of results in terms of live hard coral cover generated by the NMPDMP method and the method used during the long-term monitoring program at NMP in 1998 and 1999.

Summary of progress and main findings

- Established and surveyed 6 long-term *Drupella* monitoring sites at the southern extension of the NMP and the MIMMA.
- Re-surveyed 4 existing NMPDMP sites at NMP.
- Compared to the 'outbreak' densities recorded at NMP during the late 1980's and early 1990's *Drupella* are currently in low to moderate densities and represent no immediate threat to coral communities at NMP.
- Field Program Report completed and distributed.
- Data Report completed and distributed.
- Prepared a draft scientific paper (draft completed).
- Article to be published in LANDSCOPE magazine (December edition 07).
- Article published in Conservation News (May edition 07).
- Presented a talk at the AMSA (WA) young scientist workshop held at Rottnest Island in July 06.
- Completed a DEC Park Note (Exmouth District).
- Article published in the Exmouth Expression Newspaper (June 07).
- Completed a radio interview for ABC North West (June 07).

Management implications

- Provided baseline data for long-term monitoring of *Drupella* density and percent cover of benthic reef communities for southern NMP and MIMMA to enable trends in resource condition over time to be detected.
- Provided planning and operational management with an improved understanding of: 1) long-term changes and current status of a key performance indicator (KPI) of management of the NMP and MIMMA i.e. coral communities, 2) long-term changes to, and current status of the impact on this KPI from a known significant threat i.e. *Drupella.*

Future directions (next 12-18 months)

- As highlighted by the NMP and MIMMA management plan (2005-2015), the NMPDMP surveys will be undertaken at least every 3 years with the next major survey due in 2008.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Cold water coral bleaching survey at Ningaloo Marine Park

SPP # not yet allocated

Team members
S Armstrong (0.10), C Simpson (0.01), S Long (0.01), R Connell (0.01), R Mau (0.01), A Kendrick (0.01), K Onton (0.01); Total DEC (0.16).

Context
Coral bleaching involves the loss of coral colour due to stress-induced expulsion of symbiotic unicellular algae (Hoegh-Guldberg, 1999). Coral bleaching is usually associated with anomalously high seawater temperatures. Mass coral bleaching triggered by anomalously high seawater temperatures has been reported with growing frequency over the past 2 decades. However, the impacts of low temperature coral bleaching on reefs are less well known. To date, there are only 4 documented cases of coral bleaching resulting from anomalously low seawater temperatures. On the 15th of July 2006, the first observations of cold water coral bleaching at Ningaloo Marine Park were made. The air temperature of the previous 2 nights had been unusually cold and the combination of a spring low tide and a high pressure system resulted in the exposure of shallow corals to cold air. The results of surveys conducted by DEC in 2006 provides one of only 2 documented reports on the recovery of corals after a low temperature bleaching event and provides a summary of the first major temperature related coral bleaching event to be observed at Ningaloo Reef, Western Australia.

Aligns with Corporate Priorities 2006-2007: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J;

Aim
- To determine the spatial extent, severity of bleaching and associated recovery of corals from the 2006 winter bleaching event at Ningaloo Marine Park.

Summary of progress and main findings
- Approximately 80% of live hard coral was bleached at one of the southern shallow reef flat sites. The results of subsequent surveys suggest close to 100% recovery of corals (at the majority of NMP) from bleaching.
- Data report completed and distributed.
- Article published in Northern Guardian (April 07).
- Article published in Conservation News (June edition 07).

Management implications
- Provided planning and management with an improved understanding of the affect of low temperature anomalies on the coral communities (KPI) of Ningaloo Marine Park.
- Provided a documented report on the first major coral bleaching event to be recorded at NMP which can be used for comparison with any subsequent coral bleaching events at NMP should they occur.

Future directions (next 12-18 months)
- The Marine Science Program will continue to monitor the health of coral communities at NMP.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

List of state-wide DEC-related marine research and monitoring projects for 06/07 financial year

SPP # not yet allocated

Team members
S Armstrong (0.05), K Bancroft (0.01), C Simpson (0.01), P Van Schoubroeck (0.02); Total (0.09).

Context
To assist in a collaborative, strategic and prioritized approach toward marine research and monitoring project planning a list of all DEC-related state-wide marine research and monitoring projects for the 06/07 financial year was created.

Aim
- To create a list of state-wide DEC-related marine research and monitoring projects for the 06/07 financial year.

Summary of progress and main findings
- Developed a MS Access database located on MSP T-drive (continuously up-dated).
- Completed and distributed the list.

Management implications
- Assisted with the development of the Marine Science Program Strategy.
- Assisted with the development of the MSP 07/08 Business Plan.

Future directions (next 12-18 months)
- Continuous updating of the database.

DEC Region
Kimberley, Pilbara, Midwest, Swan, South West, Warren, South Coast.

IMCRA Regions
All State Marine Waters.

NRM Region
Northern Agricultural, Rangelands, Swan, South West, South Coast.

WA Marine Science Inventory

SPP # not yet allocated

Team members
S Armstrong (0.05), S Long (0.05), P Van Schoubroeck (0.1); Total (0.15).

Context
To assist in a collaborative, strategic and prioritized approach toward marine research and monitoring project planning a database containing information on past, current and planned WA related marine research and monitoring projects is maintained by DEC.

Aim

- To maintain an up-to-date database on past, current and planned marine research and monitoring projects in Western Australia.

Summary of progress and main findings

- Developed a MS Access database located on MSP T-drive which is continuously updated.

Management implications

- Assists with planning of future marine research and monitoring projects by providing an up-to-date list of current, completed and planned state-wide marine research and monitoring projects.

Future directions (next 12-18 months)

- The database will be continually updated on a long-term basis.

DEC Region

All (coastal).

IMCRA Regions

All State Marine Waters.

NRM Region

All (coastal).

WAMSI Node 3 Science Plan

Core function

Team members

K Waples (0.1), C Simpson (0.05); Total (0.15);

Context

The Western Australian Marine Science Institution (WAMSI) is a collaborative joint venture involving 12 partners that includes government departments, research institutions, universities and industry. The overall goal of WAMSI is to support and facilitate science that will inform decision making and develop into sound policy, planning tools and operational management of marine resources**.** The research framework within WAMSI is divided into 6 nodes or research themes. The DEC is the leader of Node 3 and the main goal of this node is managing and conserving the marine State: best practice management and underpinning science. The primary goal of node 3 is improving the scientific informational base and tools for adaptive management of marine parks to ensure sustainability of both marine ecological and socio-economic values. This is embodied in the science plan which targets research based on improving our understanding of marine ecosystems within marine parks and the tools needed to improve our management of them.

The WA government committed $5 million to the Ningaloo Research Program to undertake critical research to underpin the management plans for the marine park. The Ningaloo Research Program was incorporated into Node 3 of WAMSI and stands as the basis of the Node 3 Science Plan.

It aligns with corporate priorities 5 and 12 and KRA 2 NC2E

Aim

The Node 3 Science Plan encapsulates the range of priority research identified in the Ningaloo Marine Park Management Plan that is required to answer critical management questions about the long-term management and monitoring of the marine park. This research is critical to the long-term conservation of biodiversity and marine resources in the Pilbara Region.

Summary of progress and main findings

- Science plan developed and endorsed by WAMSI.
- Science plan presented to Ningaloo Cluster workshop and Ningaloo Tourism workshop.

Science plan distributed to WAMSI Node Leaders and Node 3 Project Leaders.

- Four research projects outlined in the Science Plan underway.

Management implications

- Outputs of the Science plan will feed directly into management plans and strategies for the Ningaloo Marine Park.

Future directions (next 12-18 months)

- Develop and initiate additional research projects outlined in the Science Plan.
- Maintain liaison with project leaders to ensure objectives from Science Plan are being met in current research projects.

DEC Region

Pilbara.

IMCRA Regions

Ningaloo, Pilbara (nearshore), Pilbara (offshore).

NRM Region

Rangelands.

WAMSI Node 3: Ningaloo Marine Park marine research and monitoring projects database

Core function

Team members

K Waples (0.1), C Simpson (0.05), S Armstrong (0.01); Total (0.16).

Context

In 2004, the Premier established the $5 million Ningaloo Research Program specifically to support research and monitoring that would provide a better scientific underpinning for management of Ningaloo Marine Park (NMP). A research framework was designed based on the strategies in the Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005-2015 (CALM, 2005) and through discussion with the research community. There is currently a very broad range of research underway at NMP by a variety of research groups, programs and organisations including CSIRO, AIMS, WAMSI, the DEC and Universities. A database was developed to capture this research, identify all individuals and parties involved and to begin to build linkages and collaboration between projects. This information will also allow the DEC to assess the research against the strategies outlined in the Management Plan and identify gaps.

It aligns with corporate priorities 6 and 12 and KRA 2 NC 2E, 2G.

Aim

- To produce a database that captures all research currently underway and planned for the NMP over the next 5 years.
- To assess this research against the management strategies outlined in the Ningaloo Marine Park Management Plan so that gaps may be identified.
- To encourage decision-makers to become aware of useful and relevant research in their planning activities.
- To encourage collaboration and linkages between research individuals, teams and programs.

Summary of progress and main findings

- Report (Bibliography of historical research and monitoring) completed and distributed.
- Report (Current and proposed marine research and monitoring projects) completed and distributed.
- Bibliographic paper submitted and accepted to 'Conservation Science' journal.
- Presentation at the AMSA junior scientist workshop at Rottnest Island, July 06.
- Excel database constructed on MSP T-drive (continuously updated).
- Provided the database to: DEC Marine Policy and Planning Branch; DEC District and Regional staff; Ningaloo Research Program project leaders (WAMSI Node 3) and other collaborating institutions and departments.
- Database further updated to include all WAMSI Node 3 projects and CSIRO Wealth from Oceans: Ningaloo Cluster projects including linkages to management strategies and objectives.

Management implications

- Improved knowledge of what information is/ will be available.
- Better integration of research effort in WAMSI Node 3.
- Integration of research on Ningaloo Marine Park between WAMSI, CSIRO Wealth from Oceans and other research institution and University research programs.

Future directions (next 12-18 months)

- Hold a 2 day symposium in July 2007 to engage with all researchers currently conducting, or planning to initiate, research projects in the Ningaloo Marine Park.
- Maintain an up to date database of current research that includes information on researcher, project objectives, application to marine park management strategies and timeframe.
- Visit the Region to discuss the research database with DEC staff, the community and other interested regional parties.

DEC Region
Pilbara.

IMCRA Regions
Ningaloo, Pilbara (nearshore), Pilbara (offshore).

NRM Region
Rangelands.

Node 3 project plans and project agreements

Core function

Team members
K Waples (0.1), C Simpson (0.05); Total (0.15).

Context

The Western Australian Marine Science Institution (WAMSI) is a collaborative joint venture involving 12 partners that includes government departments, research institutions, universities and industry. The research framework within WAMSI is divided into 6 nodes or research themes. The DEC is the leader of Node 3 and the main goal of this node is managing and conserving the marine State: best practice management and underpinning science. Research within node 3 is focussed on improving the scientific informational base and tools for adaptive management of marine parks to ensure sustainability of both marine ecological and socio-economic values with a geographical focus on Ningaloo Marine Park.

The research program for Node 3 is that established under the Ningaloo Research Program in 2005. This includes 6 main projects and up to 17 sub projects. It is the responsibility of the Node 3 leader to ensure that project proposals are prepared and those endorsed by WAMSI are further developed into project agreements so that the research may be undertaken.

It aligns with corporate priorities 5 and 12 and KRA 2 NC2E, 2G.

Aim

- To ensure that appropriate project plans are prepared and submitted to the WAMSI Research Committee for endorsement.
- To ensure that appropriate project agreements are prepared, submitted to WAMSI and endorsed so that research may be undertaken.
- To monitor the progress of research progress through review of regular progress reports.

Summary of progress and main findings

- Project Plans for 4 of the main projects (covering 12 subprojects) developed and endorsed.
- Project Agreements for 3 of the main projects developed and endorsed, the fourth has been developed and submitted.
- WAMSI web site has been established and will be further developed as a site to distribute information on the research program and progress both internally to research teams and externally to the general public.

Management implications

- Research undertaken under Node 3 will have direct implications to management strategies and actions at NMP.
- Long-term monitoring sites and strategies will be established.
- Baseline information on biodiversity and human usage and physical parameters of the park will be provided to monitor management strategies over time.

Future directions (next 12-18 months)

- Finalize the fourth project agreement.
- Develop and implement the fifth project proposal and agreement.
- Develop additional project plans and agreements as appropriate.

DEC Region
Pilbara.

IMCRA Region
Ningaloo, Pilbara (nearshore), Pilbara (offshore).

NRM Region
Rangelands.

Data and information management plan, WAMSI Node 3

Core function

Team members
K Waples (0.1), C Simpson (0.05); Total (0.15).

Context
The Western Australian Marine Science Institution (WAMSI) is a collaborative joint venture involving 12 partners that includes government departments, research institutions, universities and industry.

The research framework within WAMSI is divided into 6 nodes or research themes. DEC is the leader of Node 3 and the main goal of this node is managing and conserving the marine State: best practice management and underpinning science.

It is the responsibility of the Node 3 leader to assist in the development of project plans and agreements and to ensure that research is properly undertaken and data and information products identified and made available to the public and to those who will use the information. As such, there is a requirement in the project agreement for each project to have a data and information management plan that spells out where data will be stored over the long-term and how it will be made accessible to the public. The DEC does not currently have an appropriate storage facility or capacity to manage large marine datasets and make them available online.

It aligns with corporate priority 6 and KRA 3 NC 3J.

Aim

- To develop an interim strategy for the storage and maintenance of data and information products produced through WAMSI Node 3 research projects.
- To investigate possibilities for a WA State government data storage and management system for alternative for the long-term management of marine data.

Summary of progress and main findings

- Developed an interim plan for the storage and management of marine data gathered through WAMSI research projects.
- Provided plan to WAMSI project leaders.
- Explored alternative data storage options and discussed possibilities for including marine data (e.g. Blue Net, IVEC, DIVE, Walis).

Management implications

- Long-term storage and management of data is critical for management as information will be required by decision makers and needs to be easily located and accessible.

Future directions (next 12-18 months)

- Develop a strategy for the long-term storage and management of marine data for the DEC, and possibly, WA government.

DEC Region

Pilbara.

IMCRA Regions

Ningaloo, Pilbara (nearshore), Pilbara (offshore).

NRM Region

Rangelands.

SCIENCE APPLICATIONS

Program Leader: Dr Ian Abbott

Science Division corporate data directory and repository

Core Function

Team members

M Choo (0.5), P Gioia (0.1); Total 0.6.

Context

Numerous biological datasets exist in Science Division and in other Divisions of DEC, but little is corporatized and conveniently accessible to users in DEC and in the community. There is an increasing expectation that data collected by officers of Science Division should be better integrated and managed.

It directly supports the NatureBank vision and aligns with Corporate Priority 6,11 and KRA 1 (NC 1A), 2(PVS 2A), 6 (NC 6A, SFM 6A).

Aim

To manage and disseminate corporate information and knowledge held in Science Division.

Summary of progress and main findings

- Review and consolidation of metadata and corporate data.
- Corporate data repository (BCDR) created to manage Science Division's corporate data.
- The new ANZLIC Metadata standard is now available and steps are being taken to liaise with LANDGATE to develop an interface to their software for publishing metadata.
- All the Division's scientific data are registered in the corporate Repository and are accessible online throughout DEC's network.
- A number of databases (Mammals on Australian islands database and Seabird breeding islands database) are now incorporated into BCDR.
- External data (e.g. NATUREMAP and Kimberley Biodiversity data) are being integrated into the DEC network.
- The Division's Guideline 16 (Databases and their management), together with its associated form RF28, has been revised and is being reviewed.
- An online Science Project Plan system (WASPP) is now available. It is part of an integrated suite and existing data have been imported into the new system.
    - It is proposed that all new SPPs be updated into this system.
    - The existing data be made current.
- Inclusion of additional queries and other features.
- Development and implementation of the framework as the textual component/interface for online GIS biodiversity mapping (NatureMap).
    - External Museum data and other Science Division's corporate data are now incorporated into BCDR.
- Establishment and chairing of the Corporate Data Group within DEC and contribution to the group towards a consistent and integrated approach for managing corporate data.

Management implications

- Improves security and integrity of Science Division's databases, ensuring that data are not lost when a scientist retires or resigns.

- Satisfies the provision of the Records Management Act by preventing loss of data through retirement and resignation.
- Provides facility to satisfy FOI requirements.
- Facilitates communications within and outside the Division and Department.
- Provides easy and seamless access to all of the Division's data (and knowledge) from both within and outside the Division.

Future directions (next 12-18 months)

- Provide infrastructure and establish formalized procedures for identifying and managing corporate datasets.
- Establish a uniform approach for the management and online presentation of corporate data.
- Provide a better mechanism for backing up and archiving data currently held across the Division.
- Ongoing incorporation of Scientific data into BCDR.
- Consolidate metadata and corporate data.
    - Work towards development of an interface between Science (DEC) corporate data and Landgate's metadata publication tool.
- Improve access to the Division's corporate databases and their metadata.

Development of biodiversity indices

Core function

Team members

P Gioia (0.05); Total DEC (0.05). S Hopper, A Burbidge (external).

Context

The current DEC reserve acquisition and NRM process uses a range of inputs to help identify high priority areas with significant biodiversity values. Biodiversity indices such as species endemism and richness provide a valuable tool in this process. DEC currently uses IBRA bioregion boundaries in a range of administrative and analytical contexts. However, IBRA boundaries have been identified as having a number of shortcomings when used to represent floristic diversity in Western Australia. A more ecologically appropriate set of boundaries is highly desirable.

It aligns with Corporate Priority 1, 2, 5, 12 and KRA 1 (NC 1A), 2 (NC 2B, PVS 2A), 3 (NC 3C, NC 3G, NC 3I,) 6 (NC 6A, SFM 6A).

Aim

To develop a range of biodiversity indices using corporate databases and involving ongoing collaborative research into species distribution, richness and endemism, as well as new areas including biodiversity response to climate change and phylogeographic studies.

Summary of progress and main findings

- Literature review completed on modelling plant and animal biodiversity, particularly within the context of climate change.

Management implications

- Species richness and endemism maps are regularly used in DEC planning.

Future directions (next 12-18 months)

- Split technical paper into a methods paper and bioregionalization paper and submit by January, 2008.
- Develop a set of richness and endemism indices for vertebrate fauna.

DEC Regions
South West, Warren.

IBRA Regions
Jarrah Forest, Warren, Avon Wheatbelt.

NRM Regions
South West, Northern Agricultural.

Science Division knowledge management

Core function

Team members
P Gioia (0.2), M Choo (0.2); Total (0.4).

Context
Biodiversity information is collected as part of Science Division activities. That information is in demand from a wide variety of clients, actual and potential. However, there are a number of issues relating to how information is collected, managed, published and distributed within the Division. This project involves a set of processes for reviewing and improving how information is managed, not just within Science Division, but across the Department, and a set of subprojects for managing information in a more corporate, integrated and effective manner so that there can ultimately be a single point of entry into the knowledge held by the Division.

It directly supports the NatureBank vision and aligns with Corporate Priority 1, 2, 3, 5, 6, 8 and KRA 1 (NC 1A), 2 (NC 2B, PVS 2A), 3 (NC 3C, NC 3J), 4 (NC 4C), 6 (NC 6A, SFM 6A).

Aim
To integrate Divisional information assets and develop a single, online entry point into knowledge held within the Science Division.

Summary of progress and main findings
- New Information Technology governance structure has been implemented within DEC, consisting of Information Management Council, Information Management Technical Committee, and chairing of Corporate Data Group.
- New database conventions have been submitted by Corporate Data Group for endorsement by IMTC and IMC.

Management implications
- Key recommendations from the study tour have been implemented, including formation of a three-tiered governance structure that separates strategic management from technical discussion.

Future directions (next 12-18 months)
- Contribute to development of new DEC Information Management Plan.
- Gain endorsement of new information management policies by Corporate Executive, and implementation of new standards and protocols by Science Division, GIS section, ISS section.
- Implement strategic projects, including corporate data register, corporate data repository, enhanced Science Division web site, NatureMap, sites of significance, etc.
- Use findings from NatureMap project to promote improved data management standards and policies.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

Provision of authoritative names of WA plant taxa

Core function

Team member
P Gioia (0.05).

Context
DEC, academia and the community rely on authoritative plant names to manage floristic databases. Without authoritative names, the ability to provide and integrate information is substantially minimized. The WA Herbarium is the recognized custodian of the names of Western Australian plants. WACensus, a database system, is the Herbarium's primary mechanism for managing those names. It captures both current names and synonymies and information is disseminated widely throughout Western Australia. DEC assumes a leadership role in providing authoritative names to assist in bio-inventory, and the delivery of high quality information to a range of clients.

It is an essential component of the NatureBank vision and aligns with Corporate Priority 2, 3, 6 and KRA 1 (NC 1A), 2 (NC 2A, NC 2B, PVS 2A), 3 (NC 3C), 4 (NC 4C), 6 (NC 6A, SFM 6A).

Aim
To provide accurate and timely information on the names of WA plant taxa to assist in management of floristic databases within DEC and the wider community.

Summary of progress and main findings

- WACensus V2 has been in production since November, 2004 and is operating well.
- Integration with WA Museum is proceeding, ensuring that future systems at WAM will integrate seamlessly with WACensus to provide a single point of access for both plant and animal names.

Management implications

- The development of any database in DEC that involves plant names needs to be linked directly to WACensus data so that nomenclatural changes can be taken into account.

Future directions (next 12-18 months)

- Further embedding of WACensus information into DEC's information systems.
- Provide advice and support to WAM to facilitate future integration of species names databases

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

Online GIS biodiversity mapping (NatureMap)

Core function

Team member

P Gioia (0.45), M Choo (0.15); Total (0.6).

Context

DEC staff allocate large amounts of time and money in using desktop GIS software for mapping biodiversity. In many cases staff must undergo difficult learning curves to master the software to undertake activities such as generating information for conservation areas. A cheaper and more effective mechanism is required for DEC staff and the wider community to generate this information.

It aligns with Corporate Priority 1, 2, 4, 6 and KRA 1 (NC 1A), 2 (NC 2B, NC 2F,). 3 (NC 3H, NC 3J), 4 (NC 4C, NC 4F), 6 (NC 6A).

Aim

To develop an online system for spatially and textually querying a range of corporate biotic and abiotic datasets; provide real-time GIS functionality over the web without the need for purchasing expensive desktop GIS software and focus on the most common GIS query tasks that DEC staff perform.

Summary of progress and main findings

- In 2006/07, NatureMap received an additional $55 000 of DEC funding through the Save Our Species initiative, and $60 000 from the Avon Catchment Council Baselining project, to continue development of the project.
- Software is now in an advanced test phase, and is currently scheduled for production release in July, 2007.

Management implications

- NatureMap will significantly reduce the time spent searching for point-based biodiversity data as well as ease the process of generating species lists for any area of the State.

Future directions (next 12-18 months)

- Integration of GIS capability into FloraBase via the NatureMap GIS engine.
- Provision of extra biodiversity layers, such as predictive species distribution, landsat imagery, etc.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Species database management software (Max)

Core function

Team member

P Gioia (0.05).

Context

There is a need to provide a standard mechanism for volunteers, consultants and DEC staff to collect and manage plant species information. The mechanism should integrate with the WA Herbarium's information systems. Max is a species database management system that substantially

improves data accuracy through facilitating the correct use of names, and promotes a standard database design integrated with WAHerb, the Herbarium's specimen database.

It aligns with Corporate Priority 2, 6 and KRA 1 (NC 1C), 2 (PVS 2A), 3 (NC 3J), 6 (NC 6A, SFM 6A).

Aim

Max is a software utility that assists in the management of species databases. It uses the latest WACensus names information from the WA Herbarium to update species databases as well as provides facilities from entering specimen label information.

Summary of progress and main findings

- Fauna names are now available as a Max database, and new processes within the WA Museum are aiming to maintain faunal names in a similar manner to WA plant names from the WA Herbarium.
- A new census of fauna names from WAM will soon be available for distribution through Max.
- Max V4 is scheduled for release in September, 2007. The new version will provide support for faunal specimen data.

Management implications

- Max provides a standard mechanism for entering specimen data, as well as the capacity to check species names against the most authoritative source. This will aid the Department in better integrating its information.

Future directions (next 12-18 months)

- To implement better support for site/species organized databases through customized forms.
- Release Max V4.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Baselining the Avon NRM Region

Team members

J Richardson (1.0), T Gamblin (1.0), B Glossop (0.8), B Bayliss (0.6), J Hogben (0.4), P Gioia (0.1).

Context

This project is part of the Natural Diversity Program within the Avon Investment Plan, 2005 (Avon Catchment Council) and was won through a competitive tender process. It is part of the Department's contribution towards the NRM process.

It aligns with Corporate Priority 6 and KRA 1 (NC 1A), 2 (NC 2A) 3 (NC 3F, NC 3J, NC 3L, NC 3O), 4 (NC 4B), 6 (NC 6A).

Aim

The aim of this project is to work with other groups within the Avon Catchment Council Natural Diversity Program to develop an inventory and information management system, of information on current status, condition and major processes threatening the regions natural diversity, and to

collate, analyse and disseminate Avon biodiversity relevant data.

Summary of progress and main findings

- All required data sets collated.
- Draft Biodiversity Assessment of the Avon NRM Region nearly at draft.
- Gap analysis discussion paper nearly completed.
- Working definitions of ecosystem and community agreed upon.
- Most of the existing vegetation mapping across the Avon has been digitized, this is presently getting attributed as a GIS file. We are also developing a form for others to enter their data.
- Beard's and Hopkin's Vegetation Associations reviewed for the Agricultural area, report completed.
- Progress towards development of website to publish key findings.
- Provided support for NatureMap project, which will allow online mapping and download of Avon biodiversity data.

Management implications

- Flora conservation activities across the Avon have been reviewed, a paper is currently in preparation examining the use of these data in defining thresholds for management action.
- Part of the output will re-prioritize flora conservation activities.

Future directions (next 12-18 months)

- Complete vegetation mapping.
- Examine the suitability for some remote sensing products to: (a) baseline condition and indicate trend of patches or remnant vegetation (b) aid in soil/vegetation mapping.
- Address priority gaps in current knowledge of status and trend of biodiversity across the Avon.
- Finalize Natural Diversity Program website
- Implement ND customizations in NatureMap

DEC Regions

Wheatbelt, Swan, Goldfields.

IBRA Regions

Avon Wheatbelt, Jarrah Forest (northern), Swan Coastal Plain, Coolgardie (Southern Cross), Mallee (Western), Yalgoo, Esperance Plains.

NRM Regions

Avon.

Taxonomic descriptive data software (DELIA)

Core function

Team member

M Choo (0.1).

Context

Taxonomic and other descriptive data maintained within the Science Division and other Divisions in DEC are based on authoritative databases managed by the WA Herbarium. These data are dynamic and there is a need to integrate data not only between the descriptive databases and the WA Herbarium's information systems but also between the various descriptive databases themselves. DELIA is a database software that provides this Integration.

It aligns with Corporate Priority 2, 6 and KRA 1 (NC 1C), 3 (NC 3J), 6 (NC 6A).

Aim

To effectively manage Taxonomic Descriptive data in an integrated database environment.

Summary of progress and main findings

- DELIA is being used to manage a number of Herbarium based descriptive databases (e.g. FloraBase, and is currently being used for integrating the Kimberley Weeds with Weeds of Western Australia).
- It provides a useful tool for generating new descriptive data projects by creating templates based on existing corporate data stored in WACENSUS (e.g. It generated templates for the Baeckea project).
- Some code modifications have to be carried out to cater for format changes associated with the release of the new version of WACENSUS.

Management implications

- DELIA provides the necessary integration of DEC's descriptive data with its corporate databases.
- Provides the mechanism for streamlining and simplifying the creation and management of descriptive databases.
- Extends the contribution to descriptive data to those without in-dept knowledge of the DELTA format and applications (e.g. volunteers and other available resources).

Future directions (next 12-18 months)

- Continue to strategically support DELIA software (currently used for flora descriptive data projects) and extend the application of descriptive data to include fauna projects.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Divisional WAN and corporate database support

Core function

Team member

P Gioia (0.1).

Context

The Science Division relies on the wide area network and locally based servers to communicate information. It also maintains a number of corporate information systems that utilize the LAN and are based on high-end server technology. In conjunction with ISS (Corporate Services), this infrastructure must be overseen and supported at a whole-of-Division level to meet Divisional requirements.

It aligns with Corporate Priority 12 and KRA 1 (NC 1A, NC 1C), 3 (NC 3C, NC 3J), 6 (NC 6A).

Aim

To maintain the Divisional wide area network through regular maintenance of and updates to infrastructure; to support the physical maintenance of infrastructure that houses corporate data such as the Divisional website and key corporate systems such as WAHerb.

Summary of progress and main findings

- LAN servers in each major research centre are up to date and meeting requirements.
- Corporate databases and associated hardware and software licenses (e.g. WAHERB specimen database) are being supported and maintained.
- Backup requirements at Woodvale have exceeded capacity.

Management implications

- The Division relies on the LAN/WAN infrastructure to communicate effectively.

Future directions (next 12-18 months)

- Implement a new backup capability at Woodvale with increased capacity.

Management of Science Division corporate web sites

Core Function

Team members

B Richardson (0.2), BS Mahon (0.05), D Harding (0.05), L Wright (0.05), M Choo (0.05); Total (0.40).

Context

A final step in biodiversity research is to communicate the research results to the general community (KRA 6.1). Science Division's Intranet and Internet websites perform this role. Educators, students, environmental consultants, the tourism and mining industries and other sectors of the community rely on the availability of scientific information for their day-to-day work.

A web presence for the Division aligns with this need, and provides real-time access to the information generated by Divisional staff.

The Intranet site provides staff with access to information with an internal focus, including documents crucial to the day-to-day management of the Division.

It aligns with Corporate Priority 8 and KRA 2 (PVS 2A), 6 (NC 6A, SFM 6A).

Aim

To maintain Science Division's presence both on the Intranet and Internet.

Summary of progress and main findings

- Initiated rewrite of Herbarium systems to store and use a copy of WACensus 2 for simpler management of plant names above species rank (B Richardson; 2007).
- Initiated revision of access to WACensus data through direct Oracle connectivity (B Richardson; 2007).
- Added June Fungus of the Month (B Richardson; 06/2007).
- Corrected a problem with the number of items listed in the Science Bibliography for 2006 (L Wright, B Richardson; 05/2007).
- Added May Invertebrate of the Month (B Richardson; 05/2007).
- Added May Fungus of the Month (B Richardson; 05/2007).
- Added April Fungus of the Month (B Richardson; 04/2007).
- Karrak-watch article updates (B Richardson; 03/2007).
- Corrected link problem in new Science & Research pages in NatureBase where the Pilbara Biological Survey Database was inaccessible (B Richardson; 03/2007).
- Added March Invertebrate of the Month (B Richardson; 03/2007).
- Added March Fungus of the Month (B Richardson; 03/2007).

- Added February Fungus of the Month (B Richardson; 02/2007).
- Corrected non-functioning Intranet site search feature (B Richardson; 02/2007).
- Corrected a code duplication issue introduced during the migration of content into NatureBase (B Richardson; 02/2007).
- Corrected location for Nuytsia PDF documents as part of migration (B Richardson; 12/2006).
- Redesigned the Science & Research section of NatureBase with feedback from some members of SMT (S Smithers; 12/2006).
- Migrated static web pages (those other than database query pages) into the new NatureBase (B Richardson; 12/2006).
- Published the latest Conservation Science WA journal issue—Volume 5 Number 3 (B Richardson; 09/2006).
- Created or updated staff profiles for A Pinder, M Appelhoff, G Owen, J Moorthy, J Pearse, V Stevens, K Sutcliffe, H Townsend, M Trudgen, S Eberhard, S Grose, R Cranfield, N Burrows, G Lindsey and D Mickle (B Richardson, S Smithers; 08/2006).
- Revised text displayed in staff profiles when no research interest keywords are available (B Richardson; 08/2006)
- Changed email and Department name following the change to DEC (B Richardson; 07/2006).
- Fixed an issue with the display of staff profiles (B Richardson; 07/2006).
- Managed consultant's work on WorldWideWattle, specifically his access to the Biome server, MySQL database system, and other issues (ongoing).
- General maintenance of all sites (B Richardson, BS Mahon, L Wright, D Harding; ongoing).

Management implications

- Need for well written articles on topics of interest to DEC from Science Division, particularly those that explain scientific concepts in a way that the lay person might find interesting.
- Continue to fill the gap in publishing focus between NatureBase (very breezy) and the scientific literature (very technical).
- Avoid reliance on time-dependent content (particularly news items) so that the sites require changes less often but maintain currency for a longer period.
- Consider how the new NatureBase affects the way in which information is contributed to the Division's web presence.

Future direction

- Training in use of Joomla Content Management System (CMS) for some staff in the Division may be a priority.

Implementation of climate change biodiversity activities in DEC

Core Function

Team members

R McKellar (0.80).

Context

Climate is a fundamental determinant of a region's biological systems and taxa. For many years climate was treated as a variable factor within relatively fixed boundaries, with major changes in key climate parameters assumed to occur beyond planning horizons. Climate change is now apparent in the State's south-west and research indicates significant potential climate change impacts throughout Western Australia. International and national agreements and actions in response to global climate change can support the Department's interests or impede progress towards ecological sustainability.

It aligns with Corporate Priority 3, 6 and KRA 2 (NC 2B, PVS 2A), 3 (NC 3C, NC 3I), 6 (NC 6A, SFM 6A).

Aims

- To contribute to state, national and international understanding, agreements and activities related to climate change and biodiversity.
- To promote possible benefits from climate change initiatives such as carbon sequestration credit values.
- To integrate climate change within the Department's policy, planning and management initiatives.
- To represent the Department on state and national climate change bodies.
- To co-ordinate the implementation of State climate change / terrestrial biodiversity initiatives for which the Department is responsible.

Summary of progress and main findings

- *Landscope* article on bioclimatic impacts published.
- Finalized review of climate change–biodiversity modelling study by Pouliquen-Young and Newman (2001) for AGO. Reviewed international approaches to climate change–biodiversity modelling. Developed plan for climate change–biodiversity research (including modelling) for WA.
- Contacted DEC's south-west regions and DEC's planning branches to advise on and discuss climate change science and implications.
- Represented Department on Greenhouse IDC, IOCI, state carbon sequestration working group and national NRM climate change working groups.
- Contributed to implementation of key WA Greenhouse Strategy Action 5.5 concerned with integrated assessment of vulnerability of SW WA to climate change.
- Provided core input and support for ongoing climate research for WA (IOCI3).

Management implications

- Climate change is likely to have implications for all aspects of DEC's activities.

Future directions (next 12-18 months)

- Advise DEC staff about the implementation of Departmental activities and reporting for WA Greenhouse Strategy actions concerned with biodiversity.
- Implement Departmental reporting for National Climate Change and Biodiversity Action Plan.
- Represent WA in development of national climate change adaptation framework.
- Co-ordinate or liaise with KP Article 3.4 research (revegetation, rangeland regeneration, etc).
- Manage the DEC – SANBI science collaboration concerned with bioclimatic research programs.
- Provide updated climate change data in central information system for policy and planning use.
- Provide climate change–biodiversity information to public on website and other mechanisms.
- Develop further collaborative research initiatives concerned with climate change and biodiversity.

DEC Regions

Potentially all.

Management of terrestrial bioprospecting in DEC

Core Function

Team members

R McKellar (0.20), D Coates (0.05); Total Science Division (0.25). K Atkins, G Wyre (Nature Conservation Division).

Context

Bioprospecting is a means of generating knowledge about the capacity for Western Australia's biota to provide materials used to develop or improve medical, botanical or veterinary treatments or

pesticides. DEC is responsible for licensing access to terrestrial biota; DEC is able to form licensing agreements for access to terrestrial flora with a view to ensuring sustainability and appropriate benefit sharing.

It aligns with Corporate Priority 1 and KRA 6 (NC 6A).

Aim

To manage access to Western Australia's terrestrial flora for bioprospecting purposes in a manner that is efficient, and equitable.

Summary of progress and main findings

- Bioprospect Pty Ltd licence amended.

Management implications

- There is potential for revenues from royalties should drug discovery and development from bioprospecting succeed.

Future directions (next 12-18 months)

- Review Bioprospect Pty Ltd licence as a result of apparent change of business plan by company.
- Represent DEC in process established to resolve differing legislative approaches (a) to flora and other terrestrial biota and (b) to terrestrial and other (e.g. marine) biota.
- Contribute to WA Biodiversity Conservation Act and Strategy as they are completed.
- Respond to further commercial and institutional interest in bioprospecting as it arises.

DEC Regions

Potentially all.

Biometrics

Core Function

Team members

M Williams (0.60), A Mellican (1.0); Total (1.6).

Context

Scientific studies into any aspect of the State's biota must be underpinned by a statistically sound project design and the results analyzed with suitable methods. Just as every one of the Science Division's projects are assessed by Program leaders, for relevance to the Department's aims, every project is also assessed by the Biometrics staff to ensure that the project design is efficient and has the necessary rigor to answer the research questions posed.

It aligns with Corporate Priority 6, 12.

Aims

- To raise and maintain standards of research planning and analyses by: (i) Collaborating with staff in statistical analysis of data sets; (ii) Training staff in new methods of analysis; and (iii) Assessing all draft manuscripts ready for publication for statistical appropriateness and rigor.
- To ensure efficient experimental design by: (i) Assessing all science project plans for statistical rigor; and (ii) Providing biometrical advice to Science Division and other parts of DEC upon request.
- To extend links with regional and district staff, providing a statistical consulting service within DEC.

Summary of progress and main findings

- Science Project Plan and Manuscript databases maintained.
- Commenced analysis of FORESTCHECK data for 5-year review.
- Paper on conservation of the western ground parrot published in *Emu* (with AH Burbidge and others).
- Paper on sampling groundwater fauna submitted (with S Halse and others).
- Paper on effects of mining on *Tetratheca paynterae* submitted to *Ecological Management and Restoration* (with C Yates and others).
- Report provided to Program Leader, Fauna Conservation program on statistical aspects of the WESTERN SHIELD project.
- Drafted report on productivity of scientists in Science Division.
- Completed draft report on Mt Hampton vegetation monitoring in collaboration with Goldfields Region.

Management implications

- Biometrical scrutiny before studies commence and of scientific papers prior to submission helps safeguard technical standards, and provides confidence to managers that recommended changes to policy and operations have a sound statistical basis.

Future directions (next 12-18 months)

- Continue to assess all SPPs and manuscripts for statistical rigor.
- Complete analysis of FORESTCHECK data, and provide drafts of statistical methods to relevant authors.
- Finalize analysis of Tutanning and Stirling Range small mammal data.
- Analyse Gray forest block and Kingston bird data.
- Oversee the statistical review of WESTERN SHIELD based woylie decline data.
- Provide ongoing advice within and outside Science Division as required.

DEC Regions

All.

PERTH OBSERVATORY

Program Leader: Dr James Biggs

Astronomical Outreach and Education

Core Function

Team members

J Biggs (0.2), D Frew (0.35), R Martin (0.2), A Verveer (0.3), J Bell (0.2), A Williams (0.25), R. Tonello (0.3), vacant (0.5), G Lowe (0.5), D Johns (0.4); Total (3.2).

Context

This core function involves providing services of direct use to the general public and education sector. Its authority is underpinned by active involvement in astronomical research. Some of the projects are long-term worldwide collaborations.

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:

- Provision of lectures, talks, workshops.
- Provision of astronomy activities for visitors; star viewing, guided tours, astronomy field nights.
- Measurement of customer satisfaction and perception of quality, that is then used to assist improve service delivery.
- 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 was facilitated by the spectacular apparition of Comet McNaught in January 2007. This was the brightest comet for over 40 years and over 700 people flocked to a local beach to view the spectacle with Observatory staff. Many other people gathered all along the coast to view this ephemeral wonder. Furthermore, the Observatory was very fortunate to secure the comet's discoverer to present the 2007 Summer Lecture. Over 170 people attended this event and were treated to the inside information relating to the discovery of the comet.
- The number of visitors attending star viewing nights and day time guided tours number of visitors totaled 5,270 for the year. This is a decrease on the previous year's total resulting from the late start times for star viewing nights necessitated by imposition of daylight saving.
- A new type of star viewing session, an 'Aboriginal Astronomy Night', was successfully trialed. This activity was a collaboration with DEC's Indigenous Heritage Unit who provided the indigenous perspective on the night sky and the Observatory provided detailed star viewing with our telescopes. This activity was well received and will be continued in the future.
- Customer satisfaction remained high as in previous years, with 98 per cent satisfied with their visit or service provided by the Observatory, and, and 97 per cent satisfied with the educational quality of the services in which they participated.

Activity Measures

Activity	06/07	05/06	04/05	03/04	02/03	01/02
Star Viewing Sessions	143	183	151	212	178	185
Night Visitors	4 234	5 420	5 170	7 246	5 653	6 107
Daytime guided tours	30	37	48	80	146	122
Day visitors	1 036	1 179	1 716	2 504	4 119	3 607
Astronomy Field Nights	16	24	29	18	23	27
Field Night attendance	2045	1 244	3 293	1 524	2 496	2 833
Lectures and Talks	97	47	71	49	82	89
Talk attendance	2 191	1 748	3 067	1 283	1 990	2 899
Student consultations	56	19	15	17	86	57
Customer satisfaction (star viewing and guided tours, %)	98	98	98	98	94	94
Astronomy awareness raised (%)	98	97	97	98	95	95
Educational quality (%)	97	96	98	98	98	96

Management implications

- The substantial visitor numbers, together with sound customer satisfaction evaluations, indicates that there is continuing strong demand for these services from the Observatory.

Future directions

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

- Activity 2 - Commission the 76-cm aperture telescope - the largest telescope regularly used for public star viewing in the Southern Hemisphere. Star viewing nights also need to be re-organised owing to the imposition of daylight saving.
- Activity 4 - create the sky mapping display and commission the second internet telescope.

Astronomical Information Services

Core function

Team members

J Biggs (0.2), D Frew (0.2), R Martin (0.1), A Verveer (0.1), J Bell (0.2), A Williams (0.1), R Tonello (0.1), vacant (0.1), G Lowe (0.1), D Johns (0.2); Total (1.4).

Context

This core function involves providing information of direct use to various groups within the community. Its authority is underpinned by active involvement in astronomical research. Some of the projects are long-term worldwide collaborations.

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:

- Provision of astronomical information in response to enquiries (via telephone, email etc).
- Communication with the media regarding astronomical issues and events.
- Provision of up-to-date information resources.

- Provision of astronomical information via the WWW.
- Promotion of Perth Observatory astronomy.
- Restoration and preservation of Perth Observatory archives.
- Most of the milestones for these activities involved the maintenance of the level of activity and user participation. During the course of the year the Observatory produced 9 minor publications of an information/education nature.
- Observatory promotion and information provision via Activity 4 is an increasingly important tool for Observatory outreach. In total, there were over 1,500,000 hits on the website and nearly 20% of those occurred during the apparition of Comet McNaught. Another web development was the implementation of a database to record observations of unusual sightings submitted by the public via our website. This assists Observatory staff explain what curious sky watchers have observed and also provides a scientific record of unusual astronomical sightings.
- The Real Astronomy Experience (RAE) Internet Telescope (a collaboration with the University of California, Berkeley, and the Lawrence Hall of Science, USA) was in regular by students and scientists world wide. In particular it was successfully used by physics students at Curtin University as part of their practical astronomy course. A second internet telescope provided by the Oil Region Astronomy Society and Clarion University, USA will be commissioned this financial year. Our collaborators consider that we have developed one of the most powerful robotic telescope systems in the world. The crucial component of the system is the software developed at Perth Observatory that enables the telescope to acquire images in response to; requests from real-time users (mainly museums) all over the world, requests submitted to a queue, and it can also operate under local control in Bickley.
- This software was the basis of the refereed scientific publication: 'Piloting a network of small telescopes', Fadavi M., **Verveer A.**, Aymon J., plus 14 others including **J Biggs**, *Astronomische Nachrichten*, 327, 811-813 (2006).

Activity Measures

Activity	06/07	05/06	04/05	03/04	02/03	01/02
Telephone enquiries	13 348	14 655	11 516	19 095	9 872	11 138
Information line	3 413	2 935	1 996	3 416	1 462	1 001
Email enquiries	777	447	543	519	562	535
No. talks, lectures etc	97	47	20	49	82	89
Talk attendance	2191	1 748	1 532	1 283	1 990	2 899
Consultations	56	36	20	20	86	57
Newspaper, radio & TV	201	161	105	147	136	149
www page hits (000s)	1 519	880	709	2 200	1 116	875
Positive responses to 'quality' questions in customer surveys (%)	98	98	98	98	98	98
Satisfaction of information requests as they occur (%)	95	95	98	92	98	99

Management implications

- The sustained level of information service provision, together with sound customer satisfaction evaluations, indicates that there is continuing strong demand for these services from the Observatory. Promotion and training students in the use of the Internet telescope will consume a significant amount of Observatory resources. Likewise, upkeep of the Observatory website is a significant user of Observatory resources.

Future directions

- The activities and milestones remain essentially the same for 2006/07. 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 promotion, and training students in the use, of the RAE Internet telescope, and establishment of a second Internet telescope provided in collaboration with Clarion University, USA. Activity 3 will also benefit from the creation of the sky mapping display.

Astronomical research

Core function

Team members

Details are provided under each SPP below.

Context

This core function involves the utilization of research facilities and capitalizes its isolated location. Most of its projects are long-term worldwide collaborations.

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.
- 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 8 in minor publications (poster papers, abstracts etc). 100% of referred papers submitted were published (100% in 05/06).
- Research activities were given a major boost with a $350 000 capital works allocation to house a 1-m aperture telescope. Lowell Observatory (the USA's largest private astronomical observatory) is its current owner and they have been a partner of Perth Observatory since the establishment of their 24-inch telescope (now called the PLAT – Perth Lowell automated telescope) at Bickley in 1971. Given the Observatory's outstanding track record of maintaining the 24-inch telescope in near-new condition, upgrading it to computer control, and demonstrated ability in internet telescope access technology, Lowell Observatory are very confident that this project will prove successful and realize the significant potential of this valuable telescope.
- Most importantly, the 1-metre telescope will deliver exciting new science projects currently not feasible with the 24-inch telescope as well as better support existing science programs. The 1-metre has far more light gathering power than existing telescopes in Western Australia and this will facilitate conduct of an effective program of spectroscopy (a detailed study of the light emitted by an object). It will also complement the 'mega-science' Square Kilometre Array project currently being considered for sitting in WA as that telescope only detects the radio emissions from celestial objects, not visible light.
- Furthermore, the 1-metre telescope would be an important training tool for local universities with its ability to undertake photometric, imaging and spectroscopic programs. The Observatory has a long history of providing meaningful public programs and the new telescope would also be incorporated in these activities, as well as provide visitors with an insight into local astronomical science being undertaken.
- In 2006/07, $60 000 was allocated for this project. This facilitated the site preparation, a geotechnical survey, some preliminary engineering design and the excavation for the telescope's supporting pier. The $290 000 remainder of the capital works funding will be used to design, fabricate and construct the walls and dome in 2007/08.

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 endeavors to attract to the state the SKA, the world's largest radio telescope. The construction of the 1-m telescope enclosure will consume a substantial portion of Observatory resources in the coming financial year.

Variable star observations

SPP # 98/0009

Team members

J Biggs (0.01), D Frew (0.1), R Martin (0.01), A Verveer (0.02), A Williams (0.11), R Tonello (0.02), vacant (0.03), G Lowe (0.03); Total (0.23).

Context

This SPP involves a long-term worldwide collaboration involving the study of variable stars.

Aim

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

Summary of progress and main findings

- Monitoring observations of the central stars of planetary nebulae commenced. Also, the long-term monitoring of stars TX Pyx and SS2883 were scheduled in automatic mode on the PLAT telescope.
- The RAE internet telescope is also being used to monitor stars for possible transits by their planets. A paper detailing this technique was published in a refereed journal:
- 'On the search for transits of the planets orbiting Gliese 876', Shankland P.D., Rivera E.J., Laughlin G., plus 14 others including **J Biggs**, *Astrophysical Journal*, 653, 700-707 (2006).
- Furthermore, the RAE telescope is being used for a student project that involves a search for faint variable stars in the open star cluster κ Crucis.

Future direction

- Participation in variable star monitoring programs will continue as time and resources permit, with the milestone being the successful observation, reduction of data, and publication of results.

Imaging and spectrophotometry of comets

SPP # 98/0010

Team members

J Biggs (0.01), D Frew (0.01), R Martin (0.01), A Verveer (0.02), A Williams (0.01), R Tonello (0.02), vacant (0.03), G Lowe (0.03); Total (0.23).

Context

This SPP involves a long-term collaboration with US astronomers in the study of comets.

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

- No major observations were undertaken this financial year. Two visual estimates for the magnitude of Comet C/2006 P1 (McNaught) were published in IAU telegrams.

Future directions

- Installation of an automated focuser for the PLAT Telescope will facilitate an increased number of observations. Our partners at Lowell Observatory will undertake high priority observations as they occur.

Imaging and CCD photometry of transient and variable sources

SPP # 98/0011

Team members

J Biggs (0.04), D Frew (0.1), R Martin (0.01), A Verveer (0.02), A Williams (0.06), R Tonello (0.02), G Lowe (0.03), vacant (0.03); Total (0.17).

Context

Suitable targets are imaged and processed as appropriate.

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.
- To increase knowledge of the structure and processes within stars.

Summary of progress and main findings

- Activity was based around several student projects that include:
- Acquisition of basic photometry of stars being occulted by asteroids. This can provide accurate size and shape information for the occulting asteroid.
- Data mining of astronomical photometry catalogues fro the evidence of occultations by asteroids.
- Monitoring of asteroids and comets with the RAE telescope for regular brightness changes in order to determine their rotation periods.
- Monitoring recently-discovered novae with the RAE telescope for regular brightness variations that may indicate the binary nature of the source.
- Observation of shadow events between the moons of Uranus.

Future directions

- Suitable targets will be observed as time and resources permit.
- Future observations will be conducted using the RAE telescope and Clarion University internet telescope.

Astrometry of minor planets, comets and targets of opportunity

SPP # 98/ 0012

Team members

J Biggs (0.20), D Frew (0.01), R Martin (0.01), A Verveer (0.02), A Williams (0.01), R Tonello (0.02), G Lowe (0.24), vacant (0.24); Total (0.75).

Context

This SPP involves a long-term worldwide collaboration to track and discover asteroids and comets. Targets of opportunity are also observed as appropriate. It aligns with Corporate Priority 12.

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 2006/2007, a total of 69 (27 asteroid and 42 comet) small solar system body positions were published from RAE telescope observations.

Future directions

- Monitoring of NEOs will continue with the milestone an increased number of published positions Astronomical Outreach and Education

Monitoring gravitational microlenses

SPP # 98/0013

Team members

J Biggs (0.01), D Frew (0.01), R Martin (0.25), A Verveer (0.03), A Williams (0.30), R Tonello (0.03), G Lowe (0.03), vacant (0.03); Total (0.69).

Context

This SPP involves a worldwide collaboration that uses the gravitational microlensing effect to gain information about our galaxy, its stars and their planetary companions.

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 35 members affiliated with 21 institutions in 11 countries. Access to telescopes in Perth, South Africa, the Canary Islands, Chile, Brazil, Hawaii and Tasmania (ranging from 0.6m to 2m) allows 24-hour monitoring during the bulge season (May - August).

Summary of progress and main findings

- Members of the PLANET group are distributed worldwide, as is the telescope network, with all planning of the observing strategy for the events being followed carried out via an online 'homebase' control system written by Dr Williams, based on real-time data reduction and automatic modelling. As the night finishes at one telescope site, the next telescope to the West continues observing 24 hours a day, 7 days a week. Members anywhere in the world are able to adjust target selection and sample rates to optimise coverage of ongoing anomalies. Perth observatory, although having the smallest telescope in the collaboration, is the only site with full automation of both telescope and data reduction - most other telescopes require an observer to be present all night, every night, and reduce images manually as they select targets and control the telescope. This year, the Niels Bohr Institute in Copenhagen, Denmark, paid for Dr Williams to spend 2 weeks in Chile, observing on a 1.5m telescope there for PLANET, and at the same time, develop software to automate some of the data reduction tasks.
- One refereed paper was published: 'OGLE 2004-BLG-254: a K3 III Galactic bulge giant spatially resolved by a single microlens.', Cassan A., Beaulieu J.-P., Fouqué P., plus 37 others including R Martin and A Williams, *Astronomy & Astrophysics*, 460, 277-288 (2006).

Future directions

- Several more papers are in preparation.
- The May-September 2007 'bulge season' is underway, with several promising events already.
- A commercial automated focuser for the PLAT has been fitted to the telescope, and software to focus the telescope automatically is being developed - this should result in a large improvement in the data quality and number of useful images taken.

Supernova search

SPP # 98/0014

Team members

J Biggs (0.01), D Frew (0.01), R Martin (0.3), A Verveer (0.02), A Williams (0.1), R Tonello (0.02), G Lowe (0.03), vacant (0.03); Total (0.67).

Context

This SPP involves a long-term study of supernovae - an endpoint in stellar evolution.

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 PLAT telescope at the Perth Observatory.

Summary of progress and main findings

- Three supernovae were discovered; SN2007bl, SN2007bm and SN2007bn.
- Photometry of SN2007bm was collected on 20 nights.
- Two other supernovae were recovered.
- Ninety new galaxies were added to the supernova search list that now numbers over 4 000 galaxies.
- Work on the computer code to automatically focus the telescope was commenced and the supernova search code was ported from the os/2 operating system to the Linux operating system.

Future directions

- A scientific paper on SN2004S will be submitted for publication. An increased number of supernovae will be photometrically monitored.

Astronomical evaluation of sites in WA for observation

SPP # 00/0006

Team members

J Biggs (0.02), D Frew (0.01), R Martin (0.06), A Verveer (0.02), A Williams (0.01), R Tonello (0.02), G Lowe (0.01), vacant (0.01); Total (0.16).

Context

This SPP involves evaluation of various sites regarding their suitability for astronomical observations.

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

- Three nights of data were acquired from Mt Singleton during a Landscope expedition. Preliminary analysis suggests that the data quality is good.

Future directions

- This site evaluation project will result in a paper detailing the preliminary results of conditions for optical astronomy observing in WA.
- 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 south-west Western Australia

Progress report
Statistical analysis of the data collected in the period 2001-4 has been completed and writing of the thesis has commenced.

Scientist: **I Abbott**
Student: M Williams

Project title
Conservation and ecology of Western Australian butterflies

Progress report
The field work component of the 3 main projects in this study, namely (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) has been completed.

A manuscript on methodology has been submitted to Austral Ecology, and an extended abstract submitted for the MEDECOS conference to be held in September.

Scientist: **I Abbott**
Student: P Van Heurck

Project title
The compositional, structural, and functional succession of beetle communities in habitat mosaics created by 3 different fire regimes in the southern forests of Western Australia

Progress report
In March 2003 an intense wildfire, in heavy fuels, burnt approximately 20 000 ha of proposed National Park, north-east of Mt Frankland. The rapid southward spread of this wildfire was eventually controlled along the northern boundary of London forest block, which had been prescribed burnt in the previous spring of 2002. The contrasting intensities at which these adjoining 2 forest blocks were burnt has provided an opportunity to compare the fire impact on the biodiversity of their invertebrate communities. Beetle species represent roughly 20% of these communities, occur in all trophic guilds, and hence should be responsive bio-indicators of the differing fire seasons and intensities. An additional aim is to compare the impact on beetle biodiversity of a future patchy 'small grained mosaic' fire regime, with that of a 'normal prescribed' fire regime and a 'no-planned burn' regime, all in the adjoining forest blocks.

Initially 18 sites have been established (3 fire regimes x 3 landscape types: forest ridge, forest slope or swamp heaths x 2 replicates each). Within each site a number of distinct projects have been

designed to: 1) inventory the regional beetle fauna and locate short range endemic species; 2) monitor the appropriate spacing between pitfall traps to most effectively analyse the local beetle fauna; 3) collect litter samples to compare the fire impact on the beetle fauna of this microhabitat; 4) determine the reliability of using morphospecies within the beetle families; and 5) seasonally trap each site to compare the impact of the differing fire regimes on the composition and productivity of local beetle communities as surrogates of overall invertebrate biodiversity.

At each site, pre-mosaic fire pitfall trapping and litter collection commenced in December 2004 and was repeated 3 monthly to May 2007. To date 471 arthropod morphospecies have been distinguished of which 20.7% are beetles as predicted. The first 'small grain' mosaic fire was lit by helicopter in mid April 2005, but went out after burning about 5% of the forest block, due to low fuel quantity and high litter moisture. This treatment was re-applied in January 2006, when fuel loadings were heavier. These January 2006 fires resulted in approximately 20% of London block being burnt with a diversity of fire intensities and in a patchy mosaic pattern. Post-fire litter monitoring indicates a 90% recovery of litter cover 12 months after these mosaic fires, in comparison to 48 months after the 2003 wildfire. Early processing of 3 monthly samples indicates that beetle biodiversity may be correlated with post-fire litter recovery.

Scientist: **D Algar**
Student: S Hilmer

Project title
Energetics and thermoregulation of feral cats

Progress report
The thesis has been completed and the student is now furthering research on the topic through a PhD.

Scientist: **M Byrne**
Student: E Dalmaris

Project title
Wandoo decline: ecophysiological and genetic variation among provenances

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

This project is investigating the complex ecophysiology of Wandoo and its environment and the phylogeographical patterns of Wandoo. The tolerance of 30 Wandoo populations that cover the whole distribution of Wandoo, plus 4 co-occurring *Eucalyptus* species was investigated by carrying out 2 glasshouse experiments. Ecophysiological techniques were used (e.g. water potential measurements, gas exchange measurements) and appropriate laboratory analysis (e.g. osmotic potential) have also been completed. Data analysis has been slow due to the complex nature of the data set, but the problems are slowly being overcome. A phylogeographical study of the species, based on the analysis of its cpDNA, has been completed and the results some geographically structured patterns of diversity. Trees from high rainfall sites on the western margin of the distribution have haplotypes that appear more ancestral.

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.

High levels of pollen dispersal was determined at a site near Toodyay where a stand of *A. saligna* spp. *saligna* is planted in the vicinity of remnant stands of *A. saligna* spp. *lindleyi*. Pollen immigration of 32% was observed from the planted stand into the remnant stands over distances of 1.6 km. In contrast, pollen immigration into the planted stand from the remnant stands was much lower at 14%. This is due to the difference in floral fecundity of the 2 subspecies, where subsp. *saligna* is much more fecund and therefore produces a much greater pollen pool. The subspecies can be very difficult to tell apart in the field and diagnostic microsatellite markers have been developed that enable samples to be identified more reliably.

Scientist: **M Byrne**
Student: C Tauss

Project title

Phylogeny, phylogeography and conservation of *Reedia spathacea* in south-western Australia

Progress report

The high rainfall zone of south-west Western Australia is a globally significant centre of diversity for the large family Cyperaceae (sedges). However the evolutionary relationships within the family locally have been unclear. *Reedia spathacea* is a rare, monotypic genus restricted to a small number of disjunct wetlands that have Threatened Ecological Community conservation status. These wetlands are regionally atypical as they are maintained by factors largely independent of climate (such as artesian flow from the deep Yarragadee aquifer). These habitats may be long-term refugia for the putative relictual species *Reedia spathacea*.

Chloroplast DNA analysis is being used to investigate the historical genetic variation in the species as significant differentiation between populations would be expected if the species has been occupying refugial habitat over long time frames. RFLP assays have been completed and the data is currently being analyzed.

Scientist: **M Byrne**
Student: R Hendrati

Project title

Development of *Eucalyptus occidentalis* Endl. for revegetation

Progress report

Eucalyptus occidentalis is a species that grows naturally in south-western Australia and has been widely grown and utilized. Experiments both in controlled conditions and in the field have shown that this species can be classified as highly tolerant to salt and/waterlogging. *Eucalyptus occidentalis* is potentially an effective species for rehabilitation and reclamation of saline areas.

This project will provide genetic improvement for this species through selection and crossing of trees with improved saline and waterlogging tolerance. Family trials have assessed salinity and waterlogging tolerance. Genetic assessment of relationships has been undertaken and wide crossing designs planned to maximize the genetic gains in the traits.

Scientist: **M Byrne**
Student: C Jones

Project title
Indian Sandalwood: Genetic diversity and essential oil biochemistry of the Australian germplasm collection

Progress report
The heartwood of mature Sandalwood trees contains sesquiterpene essential oils which have been used for centuries in the manufacture of perfumes, incense and joss sticks. The timber is extremely valuable and harvesting from natural stands has led to deterioration of the natural populations. Plantation sandalwood provides an alternative source of timber to meet the demand for sandalwood products. Both Western Australian Sandalwood, *S. spicatum*, and Indian Sandalwood, *S. album*, are highly variable in oil yield and heartwood content and successful plantation development requires an understanding of this variation and the factors that influence it.

The genetic diversity of the Australian germplasm of Indian Sandalwood will be determined and correlated with the heartwood contents, oil yields and compositions. DNA has been extracted from collections of *S. album*, *S. austrocaledonicum* and *S. macgregorii* and genetic analysis is being finalized. The biosynthetic pathway of sesquiterpene biosynthesis in sandalwood has been investigated and gene sequences from the pathway have been identified.

Scientist: **M Byrne**
Student: S Stankowski

Project title
Pollen dispersal in the rare, bird pollinated shrub, *Calothamnus* sp. Whicher

Progress report
Calothamnus sp. Whicher is a rare, narrow endemic shrub that is restricted to the Whicher range in south-western Australia. Due to extensive habitat clearing for mining and agriculture, the species is fragmented across most of its distribution. While some large populations do exist in remnant native vegetation, most populations are small and restricted to road verges where habitat quality is poor.

Genetic analysis showed extremely low level of pollen dispersal between the populations with only 1-2% pollen immigration observed in 2 populations of *C*. sp. Whicher. This is in contrast with the much more extensive pollen dispersal observed in fragmented populations of its common congener *C. quadrifidus*. The low level of pollen dispersal, even over relatively short distances of <100 m, indicates that rare endemics may be more susceptible to the effects of fragmentation than more common species. It is possible that low pollen dispersal is due to disrupted plant-pollinator relationships caused by fragmentation.

Scientist: **M Byrne**
Student: L Kroiss

Project title
The potential for genetic interaction between *Cullen tenax* and *Cullen sp*. endemic to the Australian Wheatbelt

Progress report
The adoption of land use systems incorporating deep rooted perennials may reduce the influx of precipitation to the water table, thereby slowing the increase of salt affected areas. Exotic perennial pasture species, such as lucerne, are not ideal for acid soils and long rainless periods. Cullen tenax is a native perennial legume that has demonstrated promise in preliminary field evaluations for utilization as a forage crop. This project will assess risks of gene flow and hybridisation between C.

tenax and other species.

An enrichment library was made and used to design primers to amplify *C. tenax microsatellite loci*. Primers are being tested for consistency of amplification and polymorphism within *C. tenax* populations. The chosen microsatellite loci will be used genotype plants from 2 field experiments grown at The University of Western Australia Field Station over the 2006-2007 summer, as well as the progeny of those plants. For *C. tenax* and *C. australasicum* the distance of pollen movement and the rate of outcrossing will be estimated. Hybridisation events among C. tenax and 6 other related species whose natural distributions overlap with the areas where C. tenax would be deployed as a pasture crop will also be screened.

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 plantings. 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.

Transplant and common garden experiments have been completed and written up. Plants from 15 populations throughout the range were sampled for DNA and AFLP an analysis has been completed and the chapter is in draft form. The thesis is expected to be submitted in early September 2007.

Scientist: **P de Tores**
Student: Judy Clarke

Project title
Translocation outcomes for the Western ringtail possum (*Pseudocheirus occidentalis*): An assessment of survivorship, habitat use, population demographics and health of western ringtail possums following translocation, and determination of the extent of competition between western ringtail possums and common brushtail possums (*Trichosurus vulpecula*).

Progress report
Regular monitoring of survival, habitat use and health of 45 translocated western ringtail possums (*Pseudocheirus occidentalis*) has been carried out over the past 12 months. All animals originated from the Busselton region, either as displaced animals from cleared building sites (21 possums) or as rehabilitated animals from care (24 possums). All possums carried radio-collars fitted with mortality sensors. Possum releases took place at three different field sites. Two of these are 1080-baited for fox control: Leschenault Peninsula Conservation Park and Preston Beach Road at Yalgorup National Park; the third site, Martin's Tank at Yalgorup National Park, is an unbaited control site.

Scientist: **P de Tores**
Student: Helen McCutcheon

Project title
Possum ecology and health on the Geographe Coastal Plain

Progress report

The project investigates the survivorship, habitat use and health aspects of naturally occurring populations of the Western Ringtail Possum (*Pseudocheirus occidentalis*) and the Common Brushtail Possum (*Trichosurus vulpecula*). The aims are achieved by capturing and radiocollaring a subsample of each population and regularly recording details of location and habitat use. Biological samples are collected periodically to identify physiological parameters and survey the presence of infectious disease. Population size will be determined by spotlighting surveys using Distance sampling methods. The work is intended to contribute to an understanding of the viability of translocation as a management strategy for the threatened ringtail.

Scientist: **P de Tores**
Student: Gillian Bryant

Project title
The ecology of the south-west carpet python *Morelia spilota imbricata* in the northern jarrah forest of south-west Western Australia. Its role as a mesopredator – is it limiting success of translocated mammal populations?

Progress report
Twenty one pythons have been implanted with radiotransmitters since May 2006, an additional 7 had previously been implanted. Of these 28 pythons, 16 pythons are still implanted with radiotransmitters and are able to be tracked weekly. A total of 337 observations have been recorded for all pythons, with a total of 235 new locations and 99 previous locations (pythons found at the location used prior to that date). Thermal biology data is being collected regularly from each python, through both the temperature sensitive radiotransmitters and implanted temperature data loggers. Ambient air temperature and humidity is being collected at each treatment site and microhabitat temperature is collected when possible for each python location.

Scientist: **P de Tores**
Student: J Cruz

Project title
What factors regulate brushtail possum populations, Trichosurus vulpecula, in the northern jarrah forest, Western Australia? Identifying effects of long term fox control on brushtail population dynamics, behaviour and predator-prey interactions

Progress report
Extensive areas within the northern jarrah forest (NJF) of Western Australia have been subjected to ongoing fox control as part of a management strategy aimed at protecting vulnerable native species, including brushtail possums. Although fox baiting operations have been reported as successful, the effectiveness of long-term fox control in the preservation of possum populations remains largely unknown. It has been suggested that long-term fox control could result in a release of subordinate predators present in the system, (termed mesopredator release) especially cats, and this could cause deleterious effects on brushtail populations. This PhD project is therefore aimed at identifying the main extrinsic factors regulating possum populations in the NJF (e.g. predation, disease and food availability) and how these are affected by long-term fox control. In particular, the project will focus on identifying the role of mesopredator release (if it occurs) in regulating possum populations from areas subjected to long-term fox-baiting within the NJF. This will be achieved by comparing various alternative hypotheses based on a set of predictions related to the abundance, causes of mortality, habitat usage, population dynamics, interactions and survival of brushtail possums between fox-baited and unbaited areas.

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 with 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: 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 month period. 20 of these wetlands have been selected for use in the final study. Sampling included diatoms and macroinvertebrates and the measurement of physico-chemical parameters. Drafted sections of the thesis are being reviewed and prepared for first draft submission in about August 2007.

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. These are 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 J Cocking of DEC), 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 have been 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 S Halse, and will be used for environmental monitoring, palaeoenvironmental reconstruction and biodiversity applications. Submission of the thesis is expected later in 2007.

Scientist: **S Long**
Student: L D'Andrea

Project title
Using hyperspectral data to map vegetation cover and condition of the coastal area at Coral Bay, WA

Progress report
Ground-truthing of the hyperspectral overflight data is currently underway. Areas of particular management concern for DEC (degraded dunes etc in places likely to return to DEC management under early release agreements made with local pastoralists) in the vicinity of Coral Bay are providing the focus for this project. The results will not only increase DEC understanding of the condition of the coastal region of Ningaloo Marine Park, but will facilitate rapid management response to address degraded areas.

Scientist: **S Long**
Student: B Fowles

Project title
Shifting baselines in commercial and recreational fisheries at Ningaloo Marine Park

Progress report
Interviews with subjects identified with the assistance of DEC regional staff are underway in Exmouth. In combination with physical records, this study should detect changes in fishers' perceptions of what constitutes a good catch over the past 4 decades. Insights into changes in targeted fish communities over time will assist with management of Ningaloo Marine Park.

Scientist: **S Long**
Student: D Holley

Project title
Northwest dugong population movement and habitat use

Progress report
This PhD project has only recently commenced. Opportunities for communication and collaboration with indigenous groups in Shark Bay and the Kimberley, as well connections with interstate programs in the NT and Qld, are currently being explored.

Scientist: **S Long**
Student: J Neimann

Project title
Diurnal variability in beach use patterns at Bundegi, Turquoise Bay, and Coral Bay, Ningaloo Marine Park

Progress report
The second set of beach use data is currently being collected at focal areas within Ningaloo Marine Park. Data analysis of the first set is underway and expected to be completed by the end of August 2007. These data will assist with planning for minimal impact of visitors to beaches in Ningaloo Marine Park.

Scientist: **T Macfarlane**
Student: U Sirisena

Project title

Relationships and evolution in the genus *Thysanotus* (Laxmanniaceae)

The aims of the project are:

- To investigate the relationships of the species of *Thysanotus* using morphology, anatomy and DNA sequence data and arrive at an estimate of their phylogeny.
- To relate the phylogeny to life-form characteristics of the plants and their biogeography, to investigate the relationship between environment and phylogenetic history in this group which occurs over much of the Australian continent.
- To provide information to conservation authorities on the status of *Thysanotus* species derived from fieldwork.

Progress report

- Anatomical work has commenced starting with the anatomy of stems.
- The DNA extraction has commenced as a test of methods.
- Preliminary fieldwork has been carried out in WA and SA, ahead of the flowering season.

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, 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.

Experimental fires were conducted at 2 study sites (Yalgorup National Park and Yanchep National Park) in spring 2004 to examine the effect of fire intensity on tree recovery, seedling regeneration and understorey composition following prescribed burning. Both fires were of low intensity and patchy in extent. Initial post-fire measurements have been taken in autumn 2005. The control site for the study area in Yanchep National Park was accidentally burnt by a wildfire in January 2005.

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 1970s 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.

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. Tuart seedling growth and survival on ashbeds has been superior to other seedbed types, and *Agonis flexulosa* has been found to not have allellopathic effects on Tuart seedlings. Findings have been summarised in Tuart Bulletin No. 6 The role of fire in tuart decline at Yalgorup.

Robert submitted his thesis in September 2006.

Scientist: **L McCaw**
Student: J Cargill

Project title

Fate of *Eucalyptus marginata* seed from canopy store to emergence in the northern jarrah forests of Western Australia

Progress report

This project seeks to improve understanding of the factors that determine the success of jarrah seedling establishment following sheterwood harvest in jarrah forest. In contrast to jarrah, marri generally establishes an abundant crop of seedlings following harvesting and burning. Factors being investigated through experimental research include seed availability, seed viability, seedbed receptivity and losses from post-seedfall predation.

Work over the summer of 2006/07 concentrated on evaluating the current seed forecasting guidelines by sampling seed from trees of varying size and crown condition. Preliminary results suggest that considerably more seed is stored in the crown than indicated by the current guidelines. Seedfall and germination are being monitored following a post-harvest burn conducted in a shelterwood coupe at Amphion block east of Dwellingup in May 2007.

Scientist: **L McCaw**

Student: A O'Donnell

Project title

Fire patterns and vegetation structure in semi-arid woodlands and shrublands in southern Western Australia

Progress report

This study will draw on fire history information (including air photo, satellite imagery and vegetation mapping) to investigate fire patterns at the landscape level in the Lake Johnson area in southern Western Australia, where very large fires have occurred at different intervals over previous decades. Research questions include:

- How much of the landscape has been burnt at various frequencies over the last ~50 yrs for which air photo and satellite imagery records exist?
- How patchy are large fires? Does patchiness reflect effects of weather factors or underlying landscape and vegetation attributes?
- Has fire history induced changes in vegetation structure and can these changes be deduced from comparison of present day vegetation and Beard's mapping (1970s)?
- Can fire-induced boundaries be detected in the field from differences in vegetation structure or species composition (e.g. absence of fire-sensitive obligate seeder species such as *Callitris*).
- Are eucalypt woodlands in decline or is regeneration adequate to provide for long-term persistence and development?

The project will provide information to test hypotheses that:

a) fire history has led to structurally degraded vegetation, and

b) the proportion of the landscape in different post-fire age classes follows a negative exponential model.

A provisional fire history for the Lake Johnson area has now been developed. Field trips were conducted in December 2006, February 2007 and April 2007 to collect stem sections of *Callitris* for ring counting which will provide a cross reference to fire ages dated from remote sensing. Alison participated in a short course on dendrochronological techniques at the Laboratory of Tree Ring Research in Tuscon Arizona during May 2007.

Scientist: **G Pearson**

Student: T Compton

Project title

Bivalves in a tropical and temperate mudflat: physiological and morphological comparisons

Progress report

Biodiversity differences between tropical and temperate locations are well-known, for instance Roebuck Bay. Northwest Australia has over 65 bivalve species, whereas the Wadden Sea, North Western Europe has only 15 bivalve species. Reasons for these biodiversity differences are numerous, but there is still a lack of fundamental comparison studies in tropical and temperate locations.

Physiological tolerance tests and morphological measurements have been completed on bivalves from both locations. Experiments have included temperature tolerance tests, hypoxia tolerance, and internal organ measurements. Finally, spatial data from Roebuck Bay will be compared with that of the Wadden Sea to make a comparison of the 'niche' space used by bivalves in both locations.

Completed 3 years of field studies in October 2004 and now close to completion of compilation of the second of 3 papers required for completion of PhD from Groningen University in The Netherlands.

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.

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