Department of Environment and Conservation

Science Division annual research activity report

2007 – 2008




ACT NOW FOR THE FUTURE

Department of Environment and Conservation

Our environment, our future

DIRECTOR'S MESSAGE

The theme of my foreword this year is "connectivity". Just as maintaining the opportunity for connectedness is important for the conservation of biodiversity, it remains crucial for the relevance and application of scientific research in the Department of Environment and Conservation (DEC). This year has been particularly pleasing, as the Science Division and DEC are beginning to see the benefits from recent years of heightened activity in investing time and effort in both internal and external consultation, co-operation, co-ordination and collaboration. In 2007/08, the Division was involved in around 150 research-related projects in DEC, over 100 projects with external partners and 77 projects with tertiary students.

Working with DEC Divisions

Within DEC, close working relationships were maintained across a number of DEC Divisions. Examples include:

- Working closely with field officers in the Division of Regional Services on active adaptive management projects such as the Walpole Fire Mosaic Project, the Woylie Conservation Project (Warren Region) and the Operation Rangelands Restoration project at Lorna Glen (Goldfields Region).
- The Regional “science ambassador” program is working well with science ambassadors providing a conduit for information flow between Science Division and Regional Services Division. Science Ambassadors have attended and given presentations at the annual regional meetings for Midwest, Wheatbelt and South Coast Regions. These presentations have highlighted collaborative studies such as research associated with the design and assessment of success for flora translocations in the South Coast, Wheatbelt and Midwest Regions. The Division has also provided technical advice to important initiatives, such as the Gnangara Sustainability Strategy.
- Working closely with Nature Conservation Division and Sustainable Forest Management Division in provision of advice and in conservation planning. Examples include participation in the development of DEC’s nine Nature Conservation Service Region Plans; State of the Forests Report 2008 to which Science Division staff contributed significantly; establishment of a network of Fire Exclusion Reference Areas (FERA) in south-west forests in collaboration with Fire Management Services Branch; technical advice and review to the three Resource Condition Monitoring (Significant Native Species and Ecological Communities, Vegetation Condition, Wetland Condition) projects; assisting Area Management Planners with provision of accurate and relevant information relating to the Walpole Wilderness Area and adjacent parks and reserves; draft management plans for Leeuwin Ridge, Scott National Park and Gingilup Swamp Nature Reserve.
- Working closely with Environmental Management Branch, Environmental Protection Authority Services Unit and Environmental Analysis and Review Branch in the provision of advice on biodiversity surveys and conservation issues associated with resource development throughout the State. Key interactions include the strategic review of banded iron formation (BIF) ranges of the Midwest and Goldfields; input into the quarantine and hazard procedures for the Gorgon development on Barrow Island; input into the Northern Taskforce review of development hubs in the Kimberly; development of draft guidelines for biological survey and input into numerous Environmental Impact Assessment and Vegetation Clearing submissions.

Linking more effectively with universities

In addition to formal meetings between Divisional senior scientists and academic staff to share information and to identify areas of potential collaboration in the future, DEC Science Division continues to collaborate through ARC Linkage Grants, student scholarships and co-supervision of students (see summaries on page 232 of this report). In addition, over the last 12 months, three joint appointments have been made

with Western Australian Universities, two with the School of Plant Biology, University of Western Australia and one with the School of Biological Sciences, Murdoch University.

Investing in national and international collaborations

This year has seen a continuation of partnerships with the Bushfire CRC; Future Farm Industries CRC; CSIRO Project Vesta; CSIRO Clean Air Research Programs; Australian Long Term Ecological Research site network, and the Western Australian Marine Science Institution.

The Millennium Seed Bank-Western Australia partnership, now in its 8th year, has helped achieve a more secure future for many of the State's conservation-listed flora. Currently one half of all species held in storage at the Threatened Flora Seed Centre are duplicated at the Millennium Seed Bank, while the collections have provided the basis for more than 35 translocations.

The importance of the Millennium Seed Bank and similar seed stores is increasing as the scale of potential climate change impacts on species and ecosystems becomes more evident. Our understanding of potential climate change impacts has become sounder as a result of greater Divisional focus on science relating to climate change biodiversity interactions, a growing collaboration on this matter with Western Australian scientists based at tertiary institutions and our collaboration with the Climate Change Science team at the South African National Biodiversity Institute. The great similarities and key differences between Western Australia's south west region and South Africa cape region have supported the development of comparative studies and assessments which are revealing greater knowledge about the potential vulnerabilites of both regions.

Collaborating with the corporate sector

The Division has continued to develop partnerships and sponsorship arrangements with industry and corporate institutions. Examples include the Understanding Mulga project – the largest externally funded taxonomic project undertaken in Australia; the Pilbara Wattle project; and the mutually beneficial ‘embedding’ of identification botanists in the WA Herbarium by BHP Billiton Iron Ore and Rio Tinto Iron Ore.

Generating Science to support conservation

I am also mindful of the converse of connectivity. In evolution most new species form as a result of allopatry or vicariance, essentially a form of temporary isolation from other populations. In science, the great leaps forward are likely to come from individual scientists and not from committees of scientists. These acts of creative insight arise from a hard-to-characterize connection between awareness and mastery of knowledge as it is published in the professional journals and intense individual thinking about the problems to be solved.

Science Division continues to invest in maintaining a quality Departmental library of science journals, relevant grey literature including reports by ecological consultants to industry, and official documents. Library services are provided across DEC and external to the Department. A recent general usage survey found that these services are highly valued by staff across the Department. Within DEC, the Science Division usage of DEC library services is 53%, and the next highest users are Nature Conservation Division (16%), Regional Services Division (13%) and Parks and Visitor Services Division (10%).

The Library Catalogue has 155 201 records:

- 28 478 book/report titles
- 1 671 journal/newsletter titles (564 current)

- 10 765 monographic journals
- 26 528 reprints
- 65 968 indexed journal articles and book chapters
- 2 774 pamphlets
- 762 links to online resources
- 4 500 PDFs linked to catalogue records

The Science Division publishes two journals, Conservaiton Science WA and Nuytsia. Three issues of Conservation Science WA were published this year with 770 pages including two special issues – a complete translation of Dr L Diels 1906 Plant Life of Western Australian, a seminal work on Western Australian biogeography; and Ian Abbott's historical perspectives on the ecology of south western Australian vertebrates.

Three issues of Nuytsia were published with 706 pages of taxonomica support including a special issue on species of the Banded Ironstone Formation ranges of the Yilgarn Craton and the Ravensthorpe Range and Bandalup Hill to facilitate greater understanding of the biodiversity of these regions.

Science Division operates nine Research Centres with associated administration support. We cannot function without the valuable role that our administration staff play. It is the long term intention of DEC to collocate the three science metropolitan centres to a new building at Kensington. This year saw site works commence for Stage 1 which includes the Western Australian Herbarium and most sections of the Flora Conservation and Herbarium Program, the Science Directorate and the Science Division library. The total cost is estimated at over $30 million.

Science Division also operates molecular genetic laboratories and plant pathology laboratories, including the Vegetation Health Service which is the State's primary source of data for *Phytophthora* dieback identification. The Western Australian Herbarium houses the State's collections of vascular, non vascular (algae, mosses, etc.) plants and fungi totalling 683 339 specimens.

Science Division's bioregional spread of activity is summarized below:

DEC Region *	No. Projects	IBRA Bioregion **	No. Projects	IBRA Bioregion	No. Projects	IMCRA Region	No. Projects
Warren	69	Avon Wheatbelt	54	Jarrah forest	75	Central West Coast	4
Swan	64	Carnarvon	24	Little Sandy Desert	23	Ningaloo	3
South West	63	Central Kimberley	26	Mallee	40	Offshore Oceanic Shoals	1
Wheatbelt	58	Coolgardie	35	Murchison	30	North West Coast	1
South Coast	56	Central Ranges	23	Northern Kimberley	27	Pilbara Nearshore	1
Midwest	54	Dampierland	26	Nullarbor	24	Pilbara Offshore	1
Pilbara	42	Esperance Plains	50	Ord Victoria Plain	24	Shark Bay	1
Goldfields	42	Gascoyne	27	Pilbara	26		

DEC Region *	No. Projects	IBRA Bioregion **	No. Projects	IBRA Bioregion	No. Projects	IMCRA Region	No. Projects
Kimberley	38	Gibson Desert	23	Swan Coastal Plain	49		
		Geraldton Sandplains	40	Tanami	22		
		Great Sandy Desert	22	Victoria Bonaparte	26		
		Great Victoria Desert	23	Warren	50		
		Hampton	22	Yalgoo	30		

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

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

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 2008

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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.

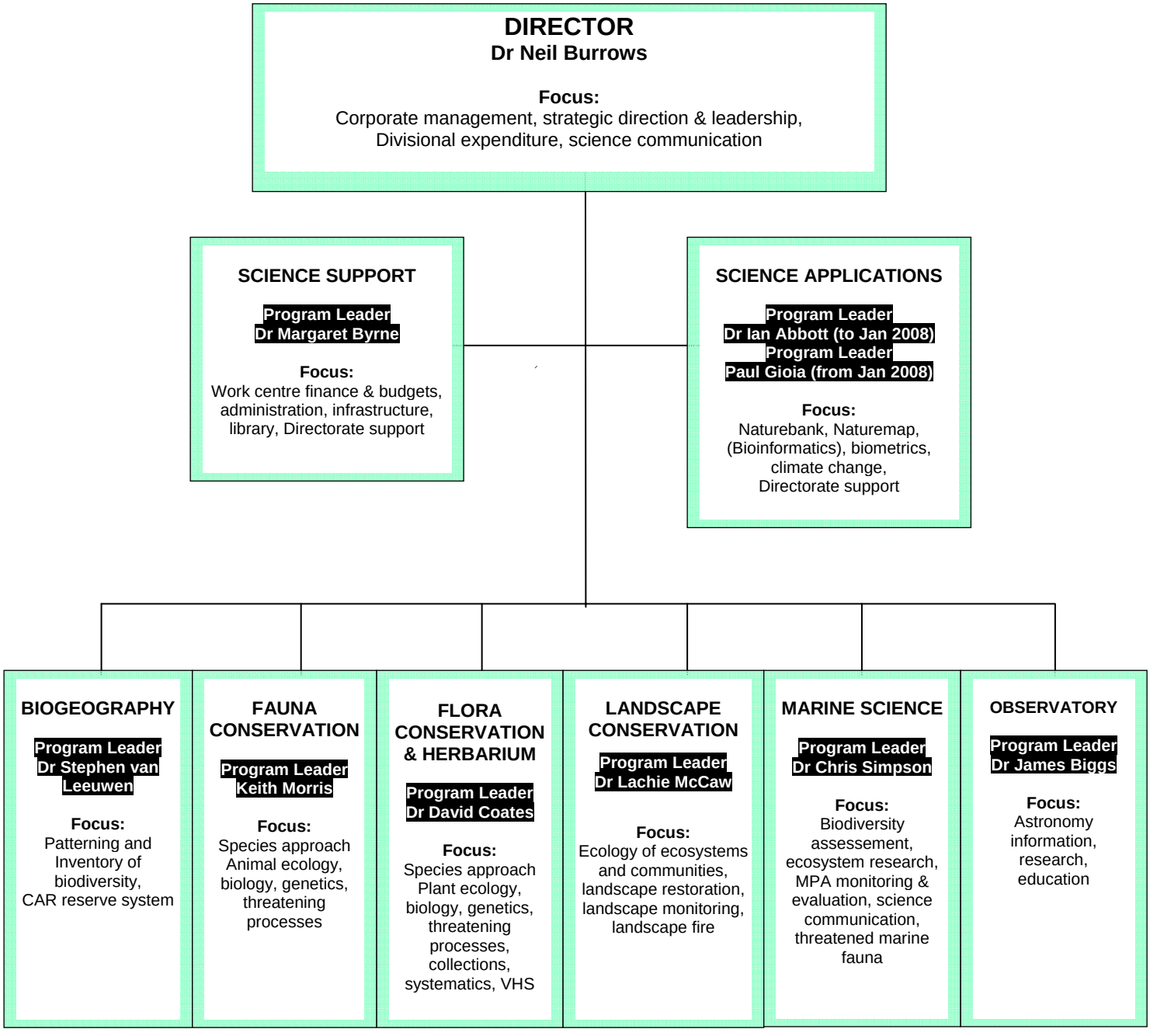
ROLE

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 end users 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, and to the broader community, 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; and
- 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	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 three 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	Completed	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	M Gee	Monitoring open star cluster Crucis	MSc	2007	Ass Prof G White	James Cook University, QLD
Biggs, James	O Geirsch	Observations of Solar Coronal Events with the Mileura Wide Field Array	PhD	2006	Ass Prof M Lynch	Curtin University
Bougher, Neale	A Francis	Sequestrate Cortinarioid fungi	PhD	2003-2007	Dr P O'Brien	Murdoch 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	2004-2008	Dr D Roberts and Dr M Bennamoun	University of Western Australia
Burrows, Neil	J Fissioli	Predicting the distribution of tingle associations in south west 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
Burrows, Neil	J Reid	Factors influencing stand structure, distribution and recruitment of *Acacia burrowsiana*	BSc Hons	2008-2009	Dr P Groom and Dr P Grierson	Curtin University/ University of Western Australia

DEC Officer	Student	Project Title	Degree /level	Duration (yr - yr)	University Academic	University
Burrows, Neil	F Metcalfe	Spatially explicit modeling of fire mosaics in south-west open dry eucalypt forest ecosystems	PhD	2008-2011	Dr Bert Veenendaal	Curtin University
Byrne, Margaret	R Butcher	Systematics of the south-western Australian endemic genus *Synaphea* R.Br. (Proteaceae: Conospermineae)	PhD	1997-2007	Prof H Lambers	University of Western 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, Sutherland D	J Cruz	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	PhD	2007-2010	L Leung	University of Queensland
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	Completed 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	Completed 2007	T Fleming	Murdoch University

DEC Officer	Student	Project Title	Degree /level	Duration (yr - yr)	University Academic	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 two 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 U Ryan	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
Friend, Tony	C Bennison	Can mice be eradicated from the Jurien Bay Islands without harming the dibbler? Developing a mouse specific bait	Hons	2008		University of Western Australia
Huisman, John	R Dixon	Systematics of Sargassum (Phaeophyceae) in Australia	PhD	2008-2010	Dr J Huisman	Murdoch University
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	C Flaherty	Persistence of Callitris patches in a highly flammable landscape, south western Australia.	Hons	2007	Dr Pauline Grierson	University of Western Australia
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
McCaw, Lachie	F Metcalfe	Spatially explicit modelling of fire severity in south-west forest ecosystems, Western Australia	PhD	2007-2010	Prof B Veenendaal, Dr W Anderson (UNSW)	Curtin 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
McKenzie, Norm	P Webala	Bat community structure and habitat use across disturbance regimes in jarrah forests, South-western Australia	PhD	2007-2009	Prof. S Bradley	Murdoch University
Morris, Keith	F Donaldson	Social structure of burrowing bettongs	PhD	2003-2009	Dr R Bencini	University of Western Australia
Morris, Keith	M Cardoso	Genetic consequences of translocation in chuditch	PhD	2005-2008	Dr K Firestone	University of Western Australia
Morris, Keith	N Willers	The use of contraceptive implants to control overabundant rock wallaby populations	PhD	2006-2009	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

DEC Officer	Student	Project Title	Degree /level	Duration (yr - yr)	University Academic	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
Radford, Ian	A Cook	Can we protect threatened mammals from severe wildfires in the north Kimberley?	PhD	2008-2011	Dr Roberta Bencinin	University of Western Australia
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
Rye, Barbara	C Motsi	Molecular systematics of *Pimelea* (Thymelaeaceae)	PhD	2005-2008	Dr M Van der Bank	University of Johannesburg
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 G Wardell-Johnson	University of Queensland
Shearer, Bryan	C Gilovitz	Intraspecific resistance to Phytophthora cinnamomi in Lambertia	Hons	2007	Dr G Hardy	Murdoch University
Simpson, Chris	B Fowles	Creating historical baselines of finfish in the Ningaloo Marine Park	Hons	2007	Dr A Gaynor	University of Western Australia
Simpson, Chris	D Holley	Northwest dugong population and habitat use	PhD	2007-9	Dr P Lavery	Edith Cowan University
Simpson, Chris	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
Simpson, Chris	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
Simpson, Chris	A Hill	The factors that contribute to the successful establishment of marine conservation reserves in Western Australia	PhD	2006-2009	Dr Syd Shea	Notre Dame University
Stukely, Mike	A Rea	Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species	PhD	2007-2010	Dr G Hardy	Murdoch University

DEC Officer	Student	Project Title	Degree /level	Duration (yr - yr)	University Academic	University
Thiele, Kevin	N Murdock	Morphological and molecular assessment of the *Petrophile brevifolia* Lindl. species complex (Proteaceae)	Hons	2008	Dr M Moody	University of Western Australia
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
Wayne, Adrian	H Burmej	Ectoparasites and Threatened Western Australian Mammals	PhD	2007-2010	Dr A Thompson. Dr A Smith	Murdoch 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
Wayne, Adrian	N Parameswarran	*Toxoplasma gondii* in Australian marsupials	PhD	2006-2009	Dr A Thompson	Murdoch University
Wayne, Adrian	U Parkar	*Blasocystis* and other protozoa in wildlife	PhD	2006-2009	Dr A Thompson	Murdoch University
Wayne, Adrian	P Wybala	Bat community structure and habitat use across disturbance regimes in jarrah forest.	PhD	2007-2009	Prof S Bradley Dr M Craig	Murdoch University
Yates, Colin	A Franks	Landscape fragmentation and rare plant species: Can we develop a general framework of population responses?	PhD	2002-2010	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
Yates, Colin	A Nield	The conservation biology of the Critically Endangered plant *Calytrix breviseta* ssp. *breviseta*	Hons	2008	Dr P Ladd	Murdoch University

EXTERNAL PARTNERSHIPS

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
AIMS	Marine biodiversity survey of the Rowley Shoals marine protected areas	AIMS provided approx $350k in kind support (staff salaries and research vessel RV Solander)	S Long (0.70); S Armstrong (0.10); H Dilley (0.10); J Huisman (0.15); S McKenna (0.03); A Edwards (0.03)
AMSA WA	Rottnest Young Scientist Workshop	Nil	S Armstrong (0.01) $500 sponsorship (all MSP CF)
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 Queensland, University of Western Australia	Broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems	$120k for three years	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) DEC $20k for three years
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	$503k over three years	D Pearson (0.5) $20k cash for three years; $112k in kind
Australia's Virtual Herbarium Trust	AVH: Australia's Virtual Herbarium: Databasing of cryptogam collections	2007-2008 ($48,502k)	C Parker (0.1), S Carroll (0.1)
Avon Catchment Council	Terrestrial Baselining of natural diversity data in Avon NRM Region	ACC funding $735k	P Gioia (0.1), J Richardson (0.8), B Bayliss (0.8), T Gamblin (1.0), Brett Glossop (0.1)
Avon Catchment Council	Aquatic Baselining the biodiversity of the Avon NRM region	2007-2008 $675k	A Pinder (0.05), S Jones (1.0), A Leung (1.0), D Halliday (1.0) and C Francis (1.0)
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).
BHP Billiton (Iron Ore and Nickel West)	Understanding Mulga Project	$190K for three years, 2007-2009	B Maslin (0.5), J Reid (0.9)
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	2006-2008 $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)

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
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 pa	P de Tores (0.75), J Asher (0.01), N Powell (0.01)
Chevron-Texaco	Monitoring mammals on Barrow Island	$6k pa for five years	K Morris (0.05), A Burbidge (0.05)
Clarion U and Oil Region Astronomical Society	Internet telescope	$1k	0.02 FTE Scientist, 0.1 FTE TO
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)	Conservation status of Banksia mimica and Pultenaea pauciflora	$58k	M Byrne (0.1), B Macdonald (0.1)
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)
CRC for Plant Based Management of Dryland Salinity	Biodiversity Program Project - Management of weed and genetic risk in perennial landuse systems	$756k over 4 years (2004-2008)	M Byrne
CSIRO	NW Shelf Research inventory	$15k	K Waples (0.05); C Simpson (0.05)
CSIRO	Pilbara Biological Survey:Australian National Insect Collection curation and identificationof Coleoptera	$10k for 2008	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 three years, 2006-2009	I Radford
CSIRO Sustainable Ecosystems	Fire, fragmentation, weeds and the conservation of plant biodiversity in Wheatbelt nature reserves	$60k for three years, 2006-2009	C Yates, C Gosper
CSIRO, Murdoch University and WWF Australia	Monitoring and evaluation of fencing and enhancement programs in WA Wheatbelt woodlands	ACC funding $106k 2008-2009; $140k 2009-2010; $59k 2010-2011; $25k 2011-2012	J Richardson (0.05)
Curtin University	Gamma ray burst – optical follow up	Nil	0.05 FTE scientist
Curtin University, Environmental Biology	Pilbara Biological Survey: Ant identifications	$10k for 2007-2008	B Durrant (0.1), S van Leeuwen (0.05)

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
Department of Agriculture and Food Western Australia, BHP, CSIRO, NHT, University of WA	Genetic purity and movements of dingos / wild dogs in the rangelands and deserts.	$25000 pa for two years 2008-2009	K Morris, N Burrows
Department of Environment and Conservation	Swan Bioplan (Strategic Policy Division)	$160k for three years, 2006-2008	G Keighery (0.2)
Department of Fisheries	Introduced Marine Pests	$28k for 2006-2007	J Huisman (0.3) (Salary)
Department of Water	Habitat requirements of Pilbara river pool invertebrates	DoW to provide $83.3k in 2008-2009	A Pinder (0.1)
DSE (Victoria) and Department DEWHA (Commonwealth)	PAPP toxicosis	$100k per yr from DEWHA	D Algar (0.05), K Morris (0.02) $10k in kind from DEC
Flinders Univeristy South Australia	A satellite tracking study of feral camels in WA	$40k one off DEC and $25k Flinders Univeristy	B Ward (0.1)
Flinders Univeristy South Austyralia , Anglo Gold	Satellite tracking of feral camels		B Ward (0.1), G Liddelow (0.1)
Fortescue Metals Group	Understanding Mulga Project	$190K for three years, 2007-2009	B Maslin (0.5), J Reid (0.9)
GCN (Gamma Ray Burst Communication Network), USA	Supernova search - SPP#1998/014	Nil	0.05 FTE scientist
Gangara Sustainability Strategy, Swan NRM, NACC, South-Coast NRM, SWCC NRM	Baselining the natural diversity of the south-west of Western Australia	$125k - externally funded by the Gnangara Sustainability Strategy, Swan NRM, NACC, South-Coast NRM, SWCC NRM	J Richardson (0.05)
Griffith University	Land and Water Australia funded TraCK project examining bioregionalization of northern Australian riverine fauna	Nil	A Pinder (0.05)
IAU Minor Planet Center, Harvard University	Asteroid tracking - SPP# 1998/012 Astrometry of minor planets, comets and targets of opportunity	Nil	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 three years (2006-2009)	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)
James Cook University	Developing a Strategic Conservation Plan for the Avon NRM Region	ACC funding. $400k 2008-2009 financial year	J Richardson (.1), B Glossop (.1)
Kimberley Land Council	Kimberley Island biological survey – Indigenous liaison and participation	NHT2 contribute $170 over two years	L Gibson (0.7), N McKenzie (0.3)

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
Land and Water Australia / CSIRO	Genetic and ecological viability of plant populations in remnant vegetation	$200k CSIRO/LWA	D Coates (0.4), M Byrne (0.1), C Yates (0.2), T llorens (1.0), B MacDonald (0.1), H. Nistleberger (1.0) $150k DEC contribution
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# 1998/010 - Imaging and spectrophotometry of comets	$2k from Lowell Observatory	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 three years – ARC Linkage Grant	T Friend (0.05)
Murdoch University	Cape Abolone Study	$75k (via MPPB)	C Simpson (0.01)
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	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	Nil	M Stukely (0.05) $5k from DEC (VHS) in 2007-2008
Murdoch University	The extraction of DNA from reptile scales and sloughed skins	Nil	D Pearson (0.05)
Murdoch University	ARC Linkage Project – Conservation of the threatened western ringtail possum, *Pseudocheirus occidentalis*: Is translocation a solution?	$110k per annum over three years	P de Tores (0.15) $15,000 pa over three years $25,000 pa ($5,000 for each of three PhD students) from SD
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	N Burrows (0.01) D Algar (0.05) DEC $5k pa for three years
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	B Johnson (0.4), K Morris (0.05) $5 k yr for 2003-2005 from Stipend funds (DEC contribution) PhD student – D Cancilla
Netherlands Institute for Sea Research (NIOZ)	Benthic studies – Roebuck Bay, NHT + Wettenhall – Roebuck Bay book	$27k	G Pearson (0.15)
NHT	Western bristlebird research plan	$50K	AH Burbidge (0.1)
NHT	Western ground parrot recovery	$200k	AH Burbidge (0.1), A Berryman (1.0)

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
NHT Regional Competitive Component	Securing a future for the dibbler – cross-regional recovery program	$108k pa for three years	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)
NHT2	Kimberley island biodiversity asset identification – Phase 1	$2.7M for 2006-2009	L Gibson (0.7), N McKenzie (0.3), F Koehler (1.0), R Palmer (1.0), M Lyons (0.4), G Keighery (0.15), D Pearson (0.05), P Handasyde (0.75), V Kessner (0.75), B Muir (0.4), J Rolfe (0.05), W Caton (1.0)
NHT2	Preparation of a recovery plan for chuditch	$10k	K Morris (0.05), J Dunlop (0.10)
NHT2	Review of the Djoongari (Shark Bay mouse) recovery plan	$3k	K Morris (0.05)
NHT2	Kimberley island biodiversity asset identification – Phase 1	$2.7M for 2006-2008	L Gibson (0.7), N McKenzie (0.3), F Koehler (1.0), R Palmer (1.0), M Lyons (0.4), G Keighery (0.15), D Pearson (0.05), P Handasyde (0.75), V Kessner (0.75), B Muir (0.4), J Rolfe (0.05), W Caton (1.0)
Ravensthorp Nickel	Determination of hybrid status of *Eucalyptus stoataptera*	$28k	M Byrne (0.1), B Macdonald (0.1)
Rio Tinto	Identification Botanist position at Western Australian Herbarium	$102,108 for 2007-2008	K Thiele (0.05)
Rio Tinto	Understanding Mulga Project	$190k for three years, 2007-2009	B Maslin (0.5), J Reid (0.9)
Robe River Iron Associates (West Angelas Coondewanna West Environmental Offsets)	Fire-Mulga study: post burn monitoring	$20k	S van Leeuwen
Robe River Iron Associates (West Angelas Coondewanna West Environmental Offsets)	Pilbara Wattle	$135k over four years, 2004-2008	B Maslin (0.1), S van Leeuwen (via Pilbara Biological Survey)
Scitech Planetarium, UWA, STAWA	Astronomy education	$1k (from grant)	0.05 FTE scientist
SCRIPT	Dibbler distribution and ecology in Fitzgerald River NP	$60k pa for three years	T Friend (0.1)
SCRIPT	Gilbert's potoroo recovery program	$187k pa for three years	T Friend (0.75)
SCRIPT	Numbat recovery program, South Coast	$34k pa for three years	T Friend (0.05)
South West NRM	Genetic and eoclogical viability of Busselton Ironstone communities	$62 725 over three years	M Byrne, B Macdonald, C Yates, N Gibson, M Langley
South African National Biodiversity Institute (SANBI)	Guidelines for bioclimatic modelling, monitoring and data management.	Funding for two years: $115 510 - Comonwealth $111 362 SANBI	R McKellar, I Abbott, C Yates, P Gioia DEC contribution $225 914

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
Space Telescope Science Institute, USA; Sth Afri Astronomical Observatory; Institut d' Astrophysique, France; U Potsdam, Germany; University of St Andrews, Scotland and University of Tasmania	PLANET - SPP# 1998/013 Monitoring gravitational microlenses	Nil	0.45 FTE scientist, 0.12 FTE TO
University of Adelaide	Pilbara biological survey/Wetland monitoring program – rotifer and cladoceran identifications - Dr R Shiel	Nil	A Pinder (0.05), D Cale (0.05) DEC contribution $20k
University of Adelaide	Pilbara biological survey/ Wetland monitoring program – rotifer and cladoceran identifications - Dr R Shiel		A Pinder (0.05), D Cale (0.05) DEC contribution $20k
University of California, Berkeley and Lawrence Hall of Science	Hands on Universe - Internet telescope	$1k	0.03 FTE Scientist, 0.1 FTE TO
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	Nil	A Pinder (0.05) DEC contribution $15k
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 three years	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) DEC $20k for three years
University of Tasmania	Using tree rings of an Australian conifer as a bioindicator of decadal-scale environmental change	Nil	L McCaw (0.1)
University of Tasmania	Understanding the health effects of landscape burningn and biomass smoke in Australian towns and cities	Nil	L McCaw (0.05) DEC $10K for three years
University of Western Australia	Benchmark study on marine communities of the south-west for long-term monitoring	NHT Grant of $180k	K Bancroft (0.01)
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)
University of Western Australia	Quaternary foraminifera of Ningaloo Reef	$5k WAMSI Node 3 to publish PhD	C Simpson $3k MSP to publish PhD thesis
Unviersity of WA, SWCC, SCRIPT	Aboriginal landscape transformations in south-western Australia	ARC Linkage	N Burrows (0.01) DEC $6k for three years

Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc)	Project	External funding and source 2007/2008 ($)	DEC Involvement (in kind) and $
WA Naturalists Club, Lotteries West	PUBF: Perth Urban Bushland Fungi project	$14,000 for 2007-2008	N Bougher (0.05), R Hart (0.5), S de Bueger (0.2), B Glossop (0.2)
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 Marine Research Inventory Project	$185,000 (from DEWHA, DOIR, DoF, Chevron, Inpex),	K Waples (0.05) $15k for 2007-2008 (MSP)
Western Australian Fisheries, WAMSI	Pinniped management plan and implementation of sea lion monitoring	$350k D; $120k external grants	R Campbell (0.5); K Crane (0.05); G Inglis (0.05) $50k from NC, $20k from SD
Western Australian Museum	Inventory and databasing of marine faunal records from the NW atolls	Nil	S Long (0.01) $60k for 2007-2008 (all MSP CF)
Western Australian Museum	NatureMap	Nil	P Gioia (0.6)
Western Australian Museum	Biogeography of insular populations in the Abrolhos	Nil	D Pearson (0.05) DEC $ 5k (Midwest Region)
Western Australian Museum	Pilbara Biological Survey	$500k in-kind in 2005-2009	N McKenzie (0.6), AH Burbidge (0.9), L Gibson (1.0)
Western Australian Police	Forensic services (botanical identifications)	$12K in 2007-2008	N Lander (0.1)
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 three years	P de Tores (0.75), J Asher (0.01), N Powell (0.01)

Note: 1k = $1 000

SUMMARY OF RESEARCH PROJECTS by DEC and NRM REGIONS

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	77
Midwest, South Coast	Northern Agricultural, South Coast	Dibbler (*Parantechinus apicalis*) Recovery Plan	78
South Coast	South Coast	Gilbert's potoroo (*Potorous gilbertii*) Recovery Plan	80
Midwest	Rangelands, Avon	Genetics and ecology of the western barred bandicoot (*Perameles bougainville*)	81
South Coast	South Coast	Disease screening and vectors of transmission in quokkas (*Setonix brachyurus*) on the mainland and Bald Island	82
Warren, South West, Swan	South West, South Coast	Rapid survey of quokka (*Setonix brachyurus*) in the southern forests	83
Warren	South West	Monitoring selected vertebrate communities in the Perup Nature Reserve	84
Warren, South West	South West	Assessing the distribution and status of the wambenger	85
Goldfields, Wheatbelt, Warren, South West	Avon, South West, Rangelands	Probait trials: phase 2	86
Wheatbelt	Avon, South West	Sustained fauna recovery in a fragmented landscape (Dryandra Woodland and Tutanning Nature Reserve)	87
Wheatbelt, South Coast, Swan, South West, Warren	South West, Swan, Avon, South Coast	Implementation of the Recovery Plan for the chuditch, *Dasyurus geoffroii*	8
Midwest	Northern Agricultural	Management of overabundant marsupials – North Island tammar wallaby case study	89
Pilbara	Rangelands	Monitoring of mammal populations on Barrow Island	90
Wheatbelt, Katanning work centre	Avon Catchment	Factors affecting fauna recovery in the Wheatbelt – Lake Magenta and Dunn Rock Nature Reserves	91
Goldfields	Rangelands	Rangelands Restoration – reintroduction of native mammals to Lorna Glen	92
Swan, Midwest	South West, Rangelands, Northern Agricultural	Ecology and conservation of threatened pythons in WA	94
Midwest	Northern Agricultural	Implementation of the Lancelin Island Skink Recovery Plan	95
All except South West	State wide	Improving rock-wallaby conservation and management	96
Kimberley	Rangelands	Impact of cane toads on biodiversity in the Kimberley	97
Midwest, Pilbara, Kimberley	Rangelands, Northern Agricultural, Swan, South West	Conservation of marine turtles	98
Wheatbelt	South West, Avon	Return to Dryandra	99
Goldfields	Rangelands	Feral camel surveys in the interior of WA	100
Warren	South West	Ecology of the ngwayir (*Pseudocheirus occidentalis*) and koomal (*Trichosurus vulpecula* hypoleucus) in the jarrah forest	101
Warren	South West	Identifying the cause(s) of the recent declines of woylies in south western Australia	103
Swan, Goldfields	Swan, Rangelands	Conservation of Western Australian butterflies	104
Swan, South West	Swan	Native earthworms (Oligochaeta) of the Swan Coastal Plain: biodiversity, distribution and threatening processes	106

DEC Region	NRM Region	Project Title	Page
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	107
Wheatbelt	Avon, Northern Agricultural, South Coast, Swan	Genetic and ecological viability of plant populations in remnant vegetation	108
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	111
All	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	112
All	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Weeds of Western Australia: advice, liaison, publicity and documentation	113
Midwest, South Coast, South West, Wheatbelt	Avon, Northern Agricultural, South Coast, South West, Swan	Experimental translocation of Critically Endangered plants	114
Midwest, Wheatbelt Region, South Coast Region, Swan Region, South West Region, Warren Region	Avon, South Coast, South West, Swan	Ecophysiology of rare flora restricted to shallow-soil communities	115
South West, South Coast	Avon, South Coast, South West, Swan	Integrated strategies for the control of *Phytophthora cinnamomi* using phosphite	117
Midwest, Swan, Wheatbelt, South West, Warren, South Coast	Avon, South Coast, South West, Swan	Susceptibility of rare and endangered flora to *Phytophthora*	117
South Coast	South Coast	The use of high intensity Phosphite techniques to control *Phytophthora cinnamomi*	118
Warren, South West, Swan, Wheatbelt	Avon, South Coast, South West, Swan	Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi*	120
South West, Swan	Avon, South Coast, South West, Swan	Dieback-resistant jarrah establishment in operational forest rehabilitation sites	121
Swan, South West, Midwest, Wheatbelt, South Coast, Warren	Northern Agricultural, Swan, Avon, South West, South Coast, Rangelands	Mundulla Yellows disease in Western Australia	122
Midwest, Swan, South West, Warren, South Coast, Wheatbelt	Northern Agricultural, Swan, Avon, South West, South Coast	Vegetation Health Service	124
Goldfields, Midwest, South West, South Coast, Swan, Wheatbelt	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	The population ecology of Critically Endangered flora	125
Goldfields	Rangelands	Causes of rarity in 4 *Tetratheca* taxa in the goldfields ranges	128
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	129
Pilbara	Rangelands	Wattles of the Pilbara	130
All	Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan	Conservation status and systematics of Western Australia *Acacia*	131

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Warren	South West	Walpole fine grain mosaic burning trial	160
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	161
South West, Warren	Avon, South West	Identification of seed collection zones for rehabilitation	162
Midwest, Wheatbelt, South Coast	Avon, Northern Agricultural, South Coast	Management of weed risk in perennial landuse systems	163
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	164
Midwest, South Coast, Wheatbelt, South West, Swan, Warren	Avon, Northern Agricultural, South West, South Coast	State Salinity Strategy wetland monitoring	165
South West, Swan, Warren	Swan, South West, South Coast	Monitoring stream biodiversity (KPI 20 for Forest Management Plan)	167
Kimberley, Goldfields, Wheatbelt, Warren	Avon, Rangelands, South West	Bushfire CRC Project B1.4: Improved methods for the assessment and prediction of grassland curing	168
South Coast	South Coast	Effects of fire on plant species, communities and fauna habitat at Two Peoples Bay Nature Reserve	169
Wheatbelt	Avon	Effects of fire on plant species and communities at Tutanning Nature Reserve	171
Swan	South West, Swan	Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the jarrah forest	172
Kimberley, Pilbara, Goldfields, Midwest, South Coast, Wheatbelt	Rangelands	Directory of important wetlands in Australia: revised editions	173
South West	South West	Management of the Vasse - Wonnerup wetlands	174
Warren	South Coast, South West	Monitoring post-fire effects from the 2001 Nuyts wildfire	176
Warren	South West	Long-term monitoring of timber harvesting on bird populations in south-west forests	177
South West, Swan, Warren	South Coast, South West, Swan	Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest	178
Warren	South West	Increasing productivity of karri regrowth stands by thinning and fertilizing	179
Goldfields, South Coast, Wheatbelt	Rangelands, South Coast	Fire induced mosaics in semi-arid shrublands and woodlands	180
Kimberley	Rangelands	Identification and monitoring of benthic invertebrate communities of tropical intertidal mudflats	181
Kimberley	Rangelands	Fire regimes and biodiversity decline in the Kimberley	183
Warren	South West	Armillaria spread in Karri	185
Warren	South West	The effect of wildfire on fungi	186
South West , Warren	South Coast, South West	Forest health and vitality surveillance and monitoring	187
South West, Swan	South West, Swan	Aspects of dieback behaviour relevant to the formulation of jarrah silviculture guidelines	188
Warren	South Coast, South West	The impact of wildfire, in old growth forest of the Walpole-Nornalup National Park, on short-range endemic invertebrates and their forest floor communities	189
Warren	South West	Effects of timber harvesting on terrestrial vertebrates in medium rainfall jarrah forest	191

DEC Region	NRM Region	Project Title	Page
South West, Warren	South West, Swan	Characteristics of hollow-bearing jarrah (*Eucalyptus marginata*) and marri (*Corymbia 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	192
South West, Warren	South West, Swan	Evaluation of key soil indicators of sustainability in Australian Mediterranean forests (Indicators 4.1d, 4.1e)	193
South West, Swan	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	194
South West	South West	Control of jarrah leafminer: selective retention of JLM resistant trees and ground coppice in a demonstration forest plot	196
Swan	Swan	Landscape and fire management interactions and their effects on distribution of invertebrate biodiversity	196
Swan	Swan	Monitoring northern extent of jarrah leafminer outbreak	197
Warren	South Coast, South West	Bushfire CRC Project B1.1: Managing fires in forested landscapes in south-west WA	198
Wheatbelt	Avon, South Coast, Rangelands	Fire, fragmentation, weeds and the conservation of plant biodiversity in Wheatbelt nature reserves	199
MARINE SCIENCE PROGRAM: CHRIS SIMPSON			
Pilbara, Kimberley, Mid west	Rangelands	North West Marine Research Inventory Inventory	202
Kimberley	Rangelands	Comparative marine biodiversity survey of the Rowley Shoals	202
Pilbara	Rangelands	Distribution and patterns of major benthic communities of the Montebello's Barrow Island marine protected areas	204
Pilbara	Rangelands	Establishing a long term monitoring program for the proposed Dampier Archipelago Marine Park	205
Pilbara	Rangelands	Three yearly Ningaloo *Drupella cornus* survey	206
Pilbara	Rangelands	Coral Bay reef recovery study / annual coral spawn observations	208
Mid west	Rangelands	Mapping of the coral reef communities of Shark Bay marine protected areas	209
Mid west	Northern Agricultural	Analysis of existing monitoring data on Jurien Bay Marine Park	210
Swan	Swan	Annual monitoring of KPIs and sanctuary zone effectiveness in metropolitan marine protected areas	211
Pilbara	Rangelands	Science coordination and administration of WAMSI Node 3 science plan and integration across WAMSI and with Ningaloo Cluster	212
Mid west	Northern Agricultural	Finalize Strategic Research Fund for Marine environemnt carry-over projects	214
SCIENCE APPLICATIONS PROGRAM: PAUL GIOIA			
South West, Warren	South West, Northern Agricultural	Development of biodiversity indices	215
All	All	Provision of authoritative names of WA plant taxa	216

DEC Region	NRM Region	Project Title	Page
All	All	Online GIS biodiversity mapping (NatureMap)	216
All	All	Species database management software (Max)	217
Wheatbelt, Swan, Goldfields	Avon	Baselining the Avon NRM region	218
Wheatbelt, Swan, Goldfields	Avon, Jarrah Forest, Swan Coastal Plain, Coolgardie, mallee, Yalgoo Esperance	Baselining the Avon NRM region (Wetlands)	220
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Potentially All		Management of terrestrial bioprospecting in DEC	223
Potentially All		Biometrics	224

SUMMARY OF SIGNIFICANT ACHIEVEMENTS ANTICIPATED for 2008/2009

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 Biological Region and make management recommendations; promote the survey findings and communicate results to key stakeholders. Continue with the Kimberley islands biological survey. Complete analysis and write-up of some eight sub-regional biological surveys. Continue floristic surveys of banded ironstone ranges in the Goldfields and complete the Ravensthorpe Range biological survey. 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 two regional marine surveys (South Coast and Kimberley). Commence targeted surveys of existing and proposed Marine Protected Areas (MPAs). Improved capacity to undertake marine research within the Marine Science Program. Development of integrated tropical and temperate marine research plans. Development of a framework to facilitate better transfer of science into policy, planning and management. Research in the Kimberley Region. **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). Maintain currency of the Divisional metadatabase.
KRA 2. Maintenance of a terrestrial / marine protected area network (IUCN management categories I to VI)	**Introduced animals**: Assist with a review of the Western Shield program. 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 introduced predator control at Lorna Glen and continue 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, identifying vulnerable species and continue with 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. Finalise study of 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. Finalise and communicate fire behaviour model, dry sclerophyll forests, Project Vesta. Assist with the implementation 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 Kimberley Fire Project to reduce greenhouse gas emissions and to conserve biodiveristy. Assist with DEC's North Kimberley Biodiversity Conservation Initiative. 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 survey native mammals for disease agents and assess impact on

Key Result Area (KRA)	Anticipated achievements
	populations . **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**: Assist the Nature Conservation Division in the development of a framework and protocols for State-level resource condition (vegetation and other biodiversity components) monitoring (NHT/NAP project). Continue to monitor wetlands as part of the State Salinity 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. Participate in the marine turtle recovery team and provide advice on the development of a marine turtle monitoring programs. Map the coral reef communities of the Shark Bay Marine Park. Improved capacity to undertake marine research within the Marine Science Program. Development of integrated tropical and temperate marine research plans. Development of an integrated marine monitoring plan for Western Australian MPAs. Development of a framework to facilitate better transfer of science into policy, planning and management. Coordination and finalization of the Ningaloo Reesearch Project. **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**: Provide technical and scientific advice to Nature Conservation and Regional Services Divisions on natural history and nature conservation issues and contribute to regional nature conservation planning and operations; Science Division staff will continue to provide support/advice to the Natural Diversity Recovery Program under the State Salinity Strategy - additional catchments, planning process for existing Natural Diversity Recovery Program and recovery catchments. Science Division staff will continue to participate in NRM planning at State and Regional levels and to provide technical support/advice. **Marine:** Improved capacity to undertake marine research within the Marine Science Program. Development of integrated tropical and temperate marine research plans. Development of a framework to facilitate better transfer of science into policy, planning and management.
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 taxonomy, 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, Midwest 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 taxonomic and 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) carry out population viability analysis and provide management guidelines for use in recovery plans. Ongoing assessment of the conservation

Key Result Area (KRA)	Anticipated achievements
	status of rare and poorly known flora thought to be critically endangered (130 taxa). Gain an understanding of the reproductive biology and 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. Continue monitoring bilby and possum reintroductions to Lorna Glen and undertake a reintroduction of mala. 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** Finalise the revised recovery plans for numbat, chuditch and rock-wallabies., prepare a recovery plan for red-tailed phascogale. 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 island survey, sub-fossil survey. **Genetics**: Develop a plan for molecular genetics surveys and research and for collecting and storing 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 and assess patterns of gene flow among fragmented populations. 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. **Marine:** Improved capacity to undertake marine research within the Marine Science Program. Development of integrated tropical and temperate marine research plans. Development of a framework to facilitate better transfer of science into policy, planning and management.
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; five training sessions held in period; Science Teachers Associations presentation; The Herbarium successfully manages 60 internal and over 300 external volunteers. Increased output of publications of results of recent research in the marine program.

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 three additional sub-regional/targeted surveys consistent with action 1.1 above.

1.21 Complete seven 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 nine 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 ACTIVITIES

BIOGEOGRAPHY

Program Leader: **Stephen van Leeuwen**

Pilbara regional biological survey

SPP# 2002/004; SPP# 2004/002

Team members

N McKenzie (0.6), N Guthrie (1.0), B Durrant (0.9), AH Burbidge (0.75), S van Leeuwen (0.65), N Gibson (0.6), M Lyons (0.4), A Pinder (0.25), L Gibson (0.25), G Keighery (0.2), D Pearson (0.05), B Bromilow (1.0), M Langley (0.8), J Rolfe (0.95); Regional assistance - P Kendrick (0.05); External assistance - S Halse, J Cocking, J McRae, M Scanlon, P Doherty, M Harvey, R Johnstone, A Baynes, B Heterick, T Weir, D Blinn, N Gunawardene, E Volschenk; Total (8.45).

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 conservation 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; two seasons from fully overlapped sampling in two 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

- All sampling and sorting complete.
- Terrestrial flora identifications seventy per cent complete.
- All terrestrial and aquatic zoological identifications complete.
- Aquatic flora identifications (macrophyte and planktonic) complete; riparian flora identifications forty per cent complete.
- Physical environment matrix for aquatic (including stygofauna) and terrestrial biodiversity sites complete.
- Matrix compiled for all taxa except terrestrial plants and riparian zone vascular plants.
- Several taxonomic revisions of stygofauna taxa published.
- Papers drafted for sub-fossil mammals, small ground-dwelling mammals and microbats.
- Fifteen presentations on progress with the Pilbara regional biological survey delivered to a wide variety of audiences from the Conservation Commission of Western Australia through to resource companies and tertiary institutions.

Management implications

- Basis for systematic regional nature conservation planning for conservation 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)

- Lodge in the Western Australian Herbarium and identify all plant vouchers and compile matrix.
- Prepare a progress and interim findings report on the survey.
- Compile the physical attribute matrix for the extra terrestrial flora sites.
- Write and submit the following papers for publication in Records of the WA Museum Supplement: Introduction (July 2008), Original mammal fauna, Small ground mammals, Microbats, Spiders, Beetles, Ants, Diatoms (August 2008), Scorpions, Birds, Reptiles, Frogs, and Surface aquatic invertebrates (September 2008), Historical birds and Stygofauna (January 2009), Wetland flora (February 2009), and Terrestrial flora (2009).
- Sent vouchers of all terrestrial vertebrate and invertebrate specimens to the WA Museum.
- Undertake road show to update Pilbara community on survey progress and findings.
- Compile terrestrial plant and zoological data-sets, then analyse, interpret and write terrestrial community paper.

DEC Region
Pilbara.

IBRA Region
Pilbara.

NRM Region
Rangelands.

Kimberley islands biological survey

SPP# 2007/001

Team members

L. Gibson (0.7), F. Koehler (1.0), R Palmer (1.0), M Lyons (0.4), G Keighery (0.15), N McKenzie (0.15), D Pearson (0.15), W Caton (1.0), P Handasyde (0.75), V Kessner (0.75), B Muir (0.4), J Rolfe (0.05), AA Burbidge (External), A Start (External); Total (6.50).

Context

Archipelagos 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.
- 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.
- First dry season survey (on Bigge, Boongaree, Katers, Middle Osborne, SW Osborne and Sir Graham Moore Islands) complete.
- Vertebrate identifications 80 per cent complete for Bigge, Boongaree, Katers, Middle Osborne, SW Osborne and Sir Graham Moore Islands
- Based on preliminary data, 36 reptile, 19 frog and 18 mammal species were recorded from the surveyed islands above.
- New vertebrates were detected from all of the above six islands, and several were recorded for the first time on islands off the Kimberley coast.
- Approximately 40 species of land snails were collected, with at least 11 undescribed species and one new genus found.
- Plant identifications 30 per cent complete for Bigge, Boongaree, Katers, Middle Osborne, SW Osborne and Sir Graham Moore Islands.
- Wet season amphibian, land snail and flora survey of Bigge, Boongaree, Katers, Middle Osborne, SW Osborne and Sir Graham Moore Islands complete.
- Land snail taxonomist appointed.
- Landscope article “Treasures of a sunken coastline” published.
- Indigenous liaison regarding access and involvement for the May-June 2008 survey (Augustus, Byam Martin, Darcy, Uwins, Coronation and St Andrew Islands) complete.
- Second dry season survey on Augustus, Byam Martin, Darcy, Uwins, Coronation and St Andrew Islands complete.

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 dry season survey of Adolphus Island.
- Conduct wet season survey of Augustus, Byam Martin, Darcy, Uwins, Coronation, St Andrew, Sunday, Long, Hidden, Storr, Molema and Kingfisher Islands.
- Conduct third dry season survey on Sunday, Long, Hidden, Storr, Molema and Kingfisher Islands.
- Complete dry season species identifications from above islands.
- Complete wet season species identifications from above islands.

DEC *Region*
Kimberley.

IBRA Regions
Victoria Bonaparte, North Kimberley, Dampierland.

NRM Region
Rangelands.

Floristic surveys of the banded ironstone formation (BIF) ranges of the Yilgarn

SPP# 2007/005

Team members

N Gibson (0.1), A Markey (1.0), R Meissner (1.0), S Dillon (1.0), G Owens (1.0); Total (4.10).

Context

To assess the conservation significance of the flora and vegetation of the banded iron formation ranges on the Yilgarn, 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 and Indian markets for iron ore.

Aims

To undertake a detailed floristic survey of the banded ironstone formation ranges 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

- Seven papers on Banded Ironstone Formation survey in press.
- A further four draft papers on Banded Ironstone Formation survey released.
- 303 quadrats sampled in 2005; 303 quadrats sampled 2006; 308 quadrats sampled in 2007
- Eleven 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 the Conservation Council's 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 banded iron formation ranges.

Future directions (next 12-18 months)

- Analyse and produce Year 3 banded iron formation report.
- Undertake 4th season (Spring 2008) banded iron formation sampling (300 quadrats).
- Analyse and produce Year 4 banded iron formation report.

DEC Regions

Goldfields, Midwest, South Coast.

IBRA Regions

Murchison, Avon Wheatbelt, Coolgardie, Yalgoo.

NRM Region

Rangelands, Northern Agricultural.

Biological survey of the Ravensthorpe Range
SPP# 2007/006

Team members
N Gibson (0.1), M Harvey (External Western Australian Museum); Total (0.10).

Context
The biodiversity values of the Ravensthorpe Range are poorly documented and the area is highly prospective for mineral exploration and mining. The Range is known for high numbers of both threatened and/or locally endemic plant species. There is no consistent flora dataset available across the Range making assessment impacts from mining proposals difficult. Each of the recent mining development in the area had significant threatened flora and vegetation issues. While knowledge of the flora and vegetation of the Range is limited even less is known of the patterns in the short-range endemic invertebrates on the Range.

Aim
To identify the biodiversity values (flora, vegetation and short-range endemic invertebrates) of the Ravensthorpe Range.

Summary of progress and main findings
- Tender let to undertake floristic survey of the Ravensthorpe Range.
- 200 quadrats sampled in 2007.
- Report on the floristic survey released.
- Tender let to undertake short-range endemic invertebrate survey of the Ravensthorpe Range.
- 74 sites sampled across the range.
- Report on the invertebrate survey released.
- 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 Saving our Species (SOS) Biodiversity Conservation Initiative (BCI) funded 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, vegetation and short-range endemic invertebrates of the Ravensthorpe Range.

Future directions (next 12-18 months)
- Provide a classification of the vegetation of the Range based on the data from the 200 quadrats previously collected.
- Provide descriptions for and an assessment of the conservation status of half the threatened, endemic and taxa with their distributions centered on the range.
- Assess the correlation between the South Coast Natural Resources Management Group (SCRIPT) mapping project and the floristic classification based on the BCI quadrat data.
- Assist in the clarification of the distribution of the Lepidosperma taxa on the Range including an assessment of their conservation status.
- Provide wider access to quadrat datasets generated by BCI project.

DEC Regions
South Coast.

IBRA Regions
Esperance Plains, Mallee.

NRM Region
South Coast.

Survey and conservation value assessment of wetlands of the Hutt River
SPP# 2007/010

Team members
A Pinder (0.1), K Quinlan (1.0); Total (1.10).

Context
The Hutt River catchment was one of the areas identified during the Wheatbelt Biological Survey as having high irreplaceability (due to its high representation of certain species assemblages) and a potential as a Natural Diversity Recovery Catchment. Analyses suggested that one of the aquatic assemblages was particularly well represented. In order to test this conclusion and more thoroughly document the biodiversity values of the Hutt River (and Hutt Lagoon) catchments a survey of the region's wetlands was undertaken.

Aims
- To describe (including sites of occurrence, within the constraints of the survey) and characterize the aquatic fauna assets (species and assemblages) of the study area.
- To identify those assets (species and assemblages) which are least well conserved at the scale of the South West (i.e., compare/contrast with the SAP and other surveys) and locally within the study area.
- To list those assets which are most important for biodiversity conservation, including consideration of local/regional endemism, phylogenetic importance, ecosystem importance, level of threat and potential economic importance.
- To describe the wetland habitat requirements (water chemistry, vegetation structure, flow etc.) of aquatic fauna assets in the catchment.

Summary of progress and main findings
- Fifteen sites were sampled in September 2007 and four were resampled in February 2008. The February trip was to resample the Hutt River which is frequently fresher in summer once flow becomes dominated by lowland springs rather than from upland secondarily saline areas.
- All samples have been processed, resulting in the collection of at least 180 species of aquatic invertebrate – probably > 220 once zooplankton identifications are finished.
- Several species are rare in the agricultural zone, especially those associated with the springs. The region is in a north-south transition zone for aquatic invertebrates and some of the species recorded are essentially northern species while others represent northward range extensions.
- Data analysis is underway and will involve multivariate analyses to classify wetland types, testing of the assemblage richness models produced during the Agricultural zone survey, assessment of the catchment for representation of assemblages identified and description of the significance of the various wetlands.
- Five groups of wetlands have been identified on the basis of their aquatic invertebrate faunas: Saline wetlands, fresh to subsaline swamps, freshwater springs, creeks and the main Hutt River channel.
- Wetland flora has been collected but is yet to be identified and analysed.

Management implications

- The report that is being produced for this catchment will contribute to a decision as to whether or not to invest in the Hutt becoming a potential Natural Diversity Recovery Catchment. The various wetland biodiversity assets will be identified to assist with prioritizing management actions.

Future directions (next 12-18 months)
Complete report.

DEC Region
Midwest.

IBRA Region
Geraldton Sandplains.

NRM Region
Northern Agricultural.

Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain
SPP# 1993/038

Team members
G Keighery (0.2); Total (0.20).

Context
The Swan Coastal Plain (SCP) is highly fragmented and impacted by settlement, urbanization and industry. Data at various levels is required to make decisions about the conservation and protection of biodiversity. This project delivers data from Swan Coastal Plain Floristic and Reserve Survey to the Swan Catchment Council and local government authorities.

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.
- Provide the Conservation Commission of Western Australia advice on significant forest flora, Whicher Range National Park.
- Participate in Perth Biodiversity Project and Regional Parks Management Plan group.
- Advice to Species and Communities Branch of DEC.
- Published taxonomic paper.
- Reserve flora checklist papers for Ridge Hill Shelf submitted.

Management implications
The basis for improved land use planning for biodiversity conservation on the Swan Coastal Plain.

Future directions (next 12-18 months)

- 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 project (DPI and DEC) project 2004-2008. Use

SCP checklist and field studies to commence updating vascular flora reservation status and reserve lists.

- Science Division representative on Swan Bioplan project.
- Complete the floristic survey of the Whicher Scarp and Dandaragan Plateau, then analyse data.
- Continue to prepare and publish taxonomic papers.

DEC Regions
Swan, South West.

IBRA Region
Swan Coastal Plain.

NRM Regions
Swan, South West.

Ecomorphological clues to community structure, bat echolocation studies
SPP# 1993/028

Team members
N McKenzie (0.1), R Bullen (External); Total (0.10).

Context
This currently underpins a component of the Pilbara regional biological survey sampling program (SPP# 2004/002), and a component of the Kimberley Islands biological survey (SPP# 2007/001).

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 community structuring processes (including disturbances) that affect the composition and richness of Western Australian assemblages by adding metapopulation information to the habitat paradigm that has previously dominated our approach to regional survey work.
- To compile a dictionary of sonar signatures for automatically recording the composition of bat assemblages on quadrats.
- To develop ecomorphological and spectral measures of potential niche (relate them to community structuring mechanisms and species' realized foraging niches).
- To investigate metapopulation and environmental factors, including disturbances, controlling the occurrence of bats.

Summary of progress and main findings

- Paper published on aerodynamic cleanliness of the wings of WA bats in context of differences between species in foraging strategies.
- Paper published on aerodynamic cleanliness of bat fur in context of difference in species foraging strategies.
- Submit paper for publication on aerodynamic cleanliness of the head/body and tail of WA bats in context of difference in species foraging strategies.
- Reference library of echolocation calls for the 17 Pilbara microbat species completed, and echolocation calls identified from the 24 survey areas sampled during the Pilbara Biological Survey.
- Data on flight capabilities, airframe attributes, and foraging strategies and microhabitats of all 17 Pilbara microbats collected and compiled.
- Submit drafted paper on the echolocation calls and habitat relationships of Pilbara microbats for

publication in the Pilbara Biological Survey Report.

- Submit drafted journal paper for publication on spectral characteristics of Pilbara microbats and their relevance to species foraging niche and community structure.

Management implications

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

Future directions (next 12-18 months)

- Draft a journal paper for publication on airframe characteristics of Pilbara microbats and their relationship to species foraging niche, community structure, and echolocation parameters.
- Develop an echolocation dictionary of Kimberley microbats, identify microbats from 19 Kimberley islands, from the ultrasound recordings being made during the current field survey (see SPP# 2007/001), and compile data on their foraging strategies, microhabitat use and airframe attributes.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Provision of biogeographical information and advice for DEC management plans, regional Natural Resource Management (NRM) plans, environmental impact assessment reviews and membership of scientific advisory committees

Core Function – Policy

Team member

S van Leeuwen (0.25), Brad Durrant (0.1), AH Burbidge (0.05), N Gibson (0.05), G Keighery (0.05), A Pinder (0.05); Total (0.55).

Context

To provide advice and liaise with managers and planners within and external to DEC (other government agencies, regional NRM groups, NGOs, peak bodies, development proponents, biological consultants, academia and land managers) on the identification and protection of the State's biodiversity assets and sustainable use of our natural resources.

Aim

To liaise with and advise managers, planners, regulators and community groups on the identification and protection of biodiversity assets across the State.

Summary of progress and main findings

- Published strategic review paper on the values of the economically prospective Banded Ironstone Ranges of the Yilgarn.
- Published papers on the modelling of threatened bird distributions and monitoring procedures.
- Provided advice on DEC response to proposed mining and land development projects throughout the State, particularly in areas of the Pilbara, Kimberley, Great Victoria Desert, Gascoyne, Murchison, Yalgoo, Swan Coastal Plain, Geraldton Sandplains, Coolgardie and Esperance Plains Bioregions.
- Represented Science Division on threatened Species Scientific Advisory Committee, Shark Bay

World Heritage committee and Gnangara Sustainability Strategy Technical Reference Group.

- Provided advice on DEC responses to proposed mining and land development projects impacting on significant ecosystems such as the vegetation communities of the Ravensthorpe Range, Banded Ironstone Ranges of the Yilgarn and heaths of the northern Kwongan; wetlands and aquifers of the West Pilbara; and subterranean fauna habitats of Barrow Island and the Robe Valley.
- Provided advice to the Environmental Protection Authority (EPA) and Environmental Impact Assessment Division, Environmental Management Branch and Environmental Analysis and Review Branch within DEC on troglofauna, stygofauna and short range endemic (SRE) invertebrate conservation and management issues and aid in the development of sampling guidelines and a risk evaluation framework for impacts assessment.
- Provided advice on Conservation Commission of WA's Performance Assessment Review of nature conservation values of vested islands along the Western Australia coastline.
- Advised DEC regional and specialist branche staff (e.g. Species and Communities Branch, Environmental Management Branch) and others (e.g. Department of Industry and Resources) in relation to survey techniques and guidelines for flora and fauna surveys; fire management for nature conservation; conservation values of various areas and ecosystems (e.g. banded ironstones, wetlands); approaches to regional conservation management; monitoring techniques; management of introduced taxa; and advice on the status and listing of threatened species and communities.
- Provide advice to CSIRO and the federal Department of the Environment, Water Resources Heritae and the Arts on the research agenda for Buffel Grass (*Cenchrus ciliaris*) and contribute to the development and deployment of a State environmental weed risk assessment framework.

Management implications

Scientific basis for effective nature conservation, natural resource management and impact mitigation

Future directions (next 12-18 months)

- Provide advice on mining and development proposals particularly in the Banded Ironstone Ranges of the Yilgarn, the sandplain of the northern Kwongan and the Pilbara and Kimberley biogeographical regions.
- Give scientific advice to the Shark Bay World Heritage committee and Gnangara Sustainability Strategy project.
- Represent Science Division on Regional Parks management planning teams and provide advice to SCNRM group on biodiversity planning.
- Provide scientific advice on SW biodiversity hotspots and Pilbara Living Country NRM initiatives.
- Provide scientific advice to the Threatened Taxa Scientific Advisory Committee.
- Prepare revised EPA Guidelines for Botanical Survey in collaboration with the Environmental Management Branch within DEC.
- Give scientific advice in relation to conservation values and their management throughout the State.
- Represent Science Division in threatened species recovery teams and in relation to regional conservation planning (e.g. in South West Australia Ecoregion Initiative, Great Western Woodlands) and climate change initiatives.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Kimberley Nature Conservation

Core Function – Policy

Team members

S van Leeuwen (0.10), L Gibson (0.05), N McKenzie (0.05), AA Burbidge (External), A Start (External); Total (0.20).

Context

The 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.

Aims

To liaise with and advise the Kimberley Regional Manager on nature conservation outputs, support nature conservation staff over technical issues and liaise with Kimberley Land Council (KLC) on projects and collaboration.

Summary of progress and main findings

- Provided advice on to the Northern Development Taskforce on the Browse Basin Gas development, and proposed National Heritage assessment.
- Represented DEC on the Browse Basin Gas development Environmental Advisory Committee.
- Ongoing liaison on nature conservation in the Kimberley with DEC regional staff, development proponents and the Kimberley Land Council.

Management implications

Protection and management of the island's biodiversity values.

Future directions (next 12-18 months)

- Ongoing liaison and advice as requested.
- Seek funding for a possible mainland West Kimberley biological survey.
- Support activities of the Kimberley Island Biological Survey.

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# 2003/005

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. 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 National Threat Abatement Plan for Predation of Feral Cats, as it was most likely to yield an operational and cost-effective method to control feral cat numbers in strategic areas.

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/km^2) 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 cat abundance.

Summary of progress and main findings

- 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, 2006 and 2007 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 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.
- 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.
- Field testing of an encapsulated toxicant (PAPP) in the feral cat bait (Eradicat) commenced this year with a field trial on French Island (Victoria). The baiting campaign produced very encouraging results with at least 70% of the cat population consuming a toxic bait. This trial is to be replicated across climatic zones in the coming year in order to fulfill APVMA requirements for registration.

Development of a technique to survey feral cat populations

Development of a new hair capture technique that reliably samples all individuals will now enable collection of data, through DNA analysis, that will be used to identify specific individuals at plots. This will provide valuable information for teasing out the abundance/activity issues that confound the indices of relative abundance and assist in the development of a more robust monitoring technique. For example, it will provide information on the independence of plots and transects. The technique may potentially be able to provide estimates of population size and also allow validation of the utility of indices.

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. An application for bait registration is currently being compiled.
- 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 project will provide for the successful reconstruction and conservation of biodiversity as part of future expansion of the Western Shield program into this region.

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 Australian Wildlife Conservancy (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}.

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

The aim of this project is to develop operational-scale introduced predator control techniques for the semi-arid bioregions in the lower rangelands.

Summary of progress and main findings

- The results for the first two years of the project have indicated that indices of introduced predator abundance can be significantly reduced for a number of months after the winter baiting. However these indices, particularly foxes, gradually increase over the summer and autumn (fox dispersal period) to a level that may inhibit native fauna recovery. The indices of cat abundance one year post-baiting were less than half of the initial level, whereas fox abundance indices increased to a level higher than that recorded at the start of the project. Successes of the first baiting program demonstrated again in the second year with complete removal of cats and almost complete removal of foxes following baiting.
- The data suggest that cat abundance at Karara has decreased while fox abundance has increased. Are these differences in the indices of relative abundance over the survey periods attributable to changes in abundance or activity? Recent development of an effective hair capture technique should enable this question to be answered.
- 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. Prey resource monitoring has been completed. The results of these prey surveys and cat/fox diet analyses are currently being drafted as several publications and a series of Museum Records/Notes.

Management implications

Research into the development of baiting strategies to provide sustained and effective integrated introduced predator control over time will extend operational introduced predator control and wildlife reintroductions to the Rangelands.

Future directions (next 12-18 months)

- It is planned to conduct a predator control program at Karara-Lochada in mid-2008, replicating that of Mount Gibson. The addition of another baited area, while removing the control site, will allow us to determine whether the baiting strategy trialed at Mount Gibson is also effective at Karara-Lochada where introduced predator numbers are high. The baseline data gathered in the first two years of the project at Mount Gibson and Karara-Lochada will be used to assess future changes in predator and prey abundance as the project heads towards completion in another two years' time.
- To address fox reinvasion in late summer/autumn should the same results occur again this year, it is proposed that an additional baiting, using fox baits, should be conducted in March-April. This program would occur in 2009 at both sites and potentially ongoing at Mt Gibson. In doing so, we aim to suppress fox numbers until the subsequent aerial Eradicat baiting in July 2009. Introduction of this program would also improve bait availability during the winter baiting. We have included an additional monitoring period for this and next year to define optimum timing for this fox baiting program.

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), A Berryman (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

- Modeling of existing Ground Parrot occurrence data from Fitzgerald River National Park assisted understanding of environmental parameters correlated with bird occurrence; scientific paper published.

- Ground Parrot surveys continued in Fitzgerald River National Park; populations in this park demonstrated to be in decline.
- Surveys in Drummond Track area continued, but no nests found.
- Survey grids established in Cape Arid National Park to provide a more systematic basis for ground parrot monitoring.
- 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.
- Proposal developed for study of impacts of cats on Ground Parrots in major south coast conservation reserves.
- Western bristlebirds translocated to D'Entrecasteaux National Park, near Walpole.
- Historical bristlebird survey data compiled into single database.
- 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 threatened fauna recovery management, especially in relation to fire, in major conservation reserves on the South Coast.

Future directions (next 12-18 months)

- Analyse and publish existing data on response to fire in bristlebirds.
- 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.
- Establish further monitoring grids that can be used in studies on impacts of cats and other predators on ground parrot populations, and gather monitoring data
- Conduct trials of remote recording units to develop increased cost-effectiveness in monitoring procedures for ground parrots
- 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), R Hill (0.25), S Garretson (0.25), L Bloomfield (0.25), L Strümpher (0.25). Casual employees: D Feeniks, J Fogarty; PhD Students – J Clarke, H McCutcheon, G Bryant; Honours students – A Nowicki, T Moore; Murdoch University – K Warren, I Robertson, T Fleming, K Bryant.

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.

The western ringtail possum translocation program commenced in 1991 and by 1998 appeared to have met the criteria for success. 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

- Fox and cat monitoring (indices to activity and estimates of density) through the use of sandplotting has commenced.
- The use of contact radio-telemetry is currently being trialled.

Management implications

Improved knowledge for recovery planning and management actions.

Future directions (next 12-18 months)

- Toxic baiting for control of cats is proposed for 2008, subject to the outcome of trials assessing the risk to non-target species.
- 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.

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 - R Hill (0.75), S Garretson (0.75), L Bloomfield (0.75), L Strümpher (0.75); casual employees: D Feeniks, T Robinson, J Turner, J Fogarty, J Read-Brain, S Mammone, H Darby; IA CRC funded post doctoral research scientists – A Glen (chuditch) (1.0) and D Sutherland (varanids) (1.0); PhD students - G Bryant (pythons) and J Cruz (brushtail possums).

Context

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. 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 Site' in Western Australia. The northern jarrah forest research is one of four components in the WA Demonstration Site.

Aims

- To test mesopredator release hypothesis at the landscape and local scale.
- To determine important site specific habitat factors (e.g. floristics, vegetation structure, vegetation structural complexity/mosaic complexity) to fauna recovery and translocation success.
- To assess the importance of prey switching and alternative prey availability to fauna recovery and translocation success.

Summary of progress and main findings

- The northern jarrah forest aerial baiting regime has continued and vehicle based ground baiting has been timed to coincide with aerial delivery of 1080 baits.
- Hair collection devices have been deployed for collection of fox and cat hair and subsequent molecular analyses (DNA to identify individuals).
- Sandplotting has been routinely carried out to derive indices to activity and estimates of density of cats and foxes
- Scat collection has also been routinely carried out to identify individual foxes and cats (a backup to hair collection) from DNA recovered from scats. Scats are also collected for predator dietary analyses.
- 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, *Varanus 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. Over 150 individuals have been captured or collected and seasonal indices to abundance across seven sites indicate a higher mean number of varanids in fox baited than unbaited areas, though variation is high.

- A novel technique has been developed to surgically implant radio-transmitters and temperature data-loggers into varanids and has been successfully employed since March 2007. Data obtained include home range use, temperatures at which varanids are active and temperature profiles of individuals at half hourly intervals over a year.
- Spool-and-line devices have been successfully designed and employed 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.
- Ten customized GPS logger units designed for mounting on varanids have been deployed at two sites. One site is baited for foxes, the other is unbaited. The loggers have not yet been recovered.
- The diet of both species is being compared in baited and unbaited sites by identifying prey items in scats and stomach contents. To date 69 samples have been collected for analysis.
- Trap timers have been developed to record the time of capture for animals entering traps. This method enables the distribution of activity times across the day to be determined for multiple species in each treatment area.
- The potential for interspecific competition between varanids, foxes and feral cats is being investigated by a mechanistic spatial model of thermal and energy requirements across the northern jarrah forest. The model is being constructed in collaboration with Michael Kearney and Warren Porter using data from this study and from other published data.
- Seasonal estimates of population density for the chuditch have been calculated from mark-recapture data for six areas (four baited, two unbaited). More than 150 chuditch have been captured on 416 occasions. On average, chuditch are more abundant in baited areas. However, chuditch populations are patchy, suggesting that factors other than baiting treatment may also be important.
- Two chuditch were fitted with radio-collars and tracked as part of a pilot study. It was subsequently decided that GPS data loggers would be more suitable to give detailed information on the movements of chuditch. Ten custom-made GPS loggers were obtained, of which six have been deployed, with results pending.
- A successful pilot study was completed to determine the suitability of spool-and-line tracking for sampling microhabitat use of chuditch. Continued tracking has been conducted using this method. Preliminary results show some use of arboreal habitats, as well as frequent use of fallen logs and subterranean burrows.
- Scat samples have been collected from trapped chuditch in order to analyse the diet of the species relative to prey availability. 247 samples have been sent to a specialist for analysis. These results will also be compared to dietary data for other predators, including foxes and varanids.
- A carcass was recovered belonging to a juvenile chuditch that had been killed by a larger predator. Analysis by a collaborator at the University of Western Australia of DNA from the bite wounds identified the predator as a cat. This constitutes the first confirmed record of a chuditch being killed by a feral cat, although such impacts were previously suspected to occur.

Management implications

- 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 two of the three 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 two large species of predatory varanids

(*Varanus gouldii* and *V. rosenbergi*) show a mesopredator release response.

Future directions (next 12-18 months)

- Contact telemetry will be further trialled
- Routine collection of sandplotting and trapping data will continue
- A field trial to assess the non-target risks of the cat bait "Eradicat" is proposed for spring/summer 2008
- 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# 1993/145

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 eight 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 monitoring populations on DEC-managed estate.

This project has been part funded over the last three years by NHT through the SCNRM group under the Southern Prospects investment plan via the project 'Implementing recovery plans for South Coast Threatened Species', commencing in July 2005 and finishing in June 2008. An extension of this umbrella project will provide funding for the numbat project from July 2008-June 2009 while the Caring for our Country investment strategies for the following four years are being developed.

It aligns with Corporate Priorities 5, 8 and 12, KRA 4, KRA 6 and sub-outputs NC 4A and NC 4C for 2007/2008.

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

- The first translocation of numbats to Cocanarup Timber Reserve, near Ravensthorpe, was carried out in December 2006, with the release of 12 captive bred subadult numbats and two wild adult males from Dryandra. This release occurred three weeks after a wildfire burnt through about half of the available habitat in the Phillips River Valley. A high rate of predation by raptors was recorded and with some other deaths and the loss of one animal's signal, by July 2007 only one numbat, an adult male, was known to survive. It is likely raptors from the adjacent burnt area were operating in the release area, increasing predation pressure at the time of release. In the expectation that raptor numbers would have decreased, a second release was carried out in December 2007. A total of 12 numbats, including eight bred at Perth Zoo and four (two adult males and two subadult females) from Dryandra, comprised the release group. The rate of survival so far has been much higher than last year, with five animals surviving as at the end of May 2008, including two females with pouch young.
- The study of dispersal and mortality rates and causes amongst juvenile numbats at Dryandra continued in 2007/2008 with the radio-collaring of 13 numbat young in October and early November 2007. In 2006/2007, all 10 young numbats radio-collared had died by the end of June 2007. Survival rates are slightly higher this year, with three of the 13 young known to be alive by the end of June, another having lost its collar, one signal lost and eight known to be dead. Deaths were due to predation by raptors (three), a chuditch (one), a python (one) and unknown predators (four). The high mortality rate amongst young numbats at Dryandra may be the key to the low population numbers currently found there. Once sufficient data are collected a population model will be constructed to examine the viability of the Dryandra population.
- In the second year of another project, to monitor movements in the early stages of independence, two families of two juvenile numbats and their mother were radio-tracked continuously for one week each using four 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 2008.
- The annual driven survey, to monitor numbers, was carried out in November 2007 at Dryandra Woodland. Results indicated that population numbers have fallen slightly from the high of the previous year. An April driven survey was also carried out for the first time in five years, while 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 2008/2009.
- Diggings searches were carried out at Stirling Range National Park (SRNP), where numbats were reintroduced between 1998 and 2004. Fresh numbat sign, indicating the presence of at least one animal, was found in one area in a long-unburnt block. Systematic searches will be carried out across a wider area within SRNP in early summer 2008/2009.
- 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 submitted for publication.
- The Numbat Recovery Plan is being revised.
- A numbat survey workshop was held at Dryandra with Warren Region staff in June 2008, teaching recognition of numbat presence through searches for diggings and scats. Further training will be carried out for Warren staff in November 2008.

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, the 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 November 2008, with the aim of increasing District involvement in monitoring.
- Another release of zoo-bred numbats will occur at Cocanarup in December 2008, given recovery team support.
- A survey for numbats and feral cats at Dragon Rocks is proposed in 2008/2009, 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.

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# 1993/149

Team members

T Friend (0.05), Total (0.55).

Context

The red-tailed phascogale (RTP) 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*.
- To determine distribution and habitat preferences of the red-tailed phascogale in the South Coast Region.

Summary of progress and main findings

In 2005, fox control ceased on two reserves that had been baited since 1994, creating an opportunity to refine this investigation into the effect of baiting. Monitoring rounds were carried out in April/May 2007 and 2008. Results supported earlier conclusions that red-tailed phascogale numbers are not strongly influenced by fox control, although in both years numbers were low at all sites, probably due the low rainfalls in the previous years. 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 the effects of fox control project to date will be written up during 2008/2009. However it would be valuable to establish an ongoing (e.g. two yrly) monitoring round and this is likely to receive some District support.
- Studies on red-tailed phascogales in the South Coast NRM region will continue in 2008/2009 and will comprise further 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 when further colonies are discovered there.
- A recovery plan for the RTP is currently being completed involving community input. 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# 1995/011

Team members

T Friend (0.05), T Button (0.9), K Rusten (0.5), Louisa Bell (0.5); Total (1.95).

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 National Park (FRNP).

Summary of progress and main findings

- Over the three-year period July 2005-June 2008, funding for the Dibbler Recovery Plan has been available from two sources.

- Monitoring of the two Western Shield transects in the FRNP showed that numbers were still high in 2007/2008.
- Population numbers on Boullanger and Whitlock Islands are high. Numbers on Escape Island have fallen each year since 2006. King's skink numbers on Escape Island have increased and this may have affected dibbler trapability.
- A three-year population study has continued at a newly discovered dibbler site with all-weather access in the eastern FRNP. This site provides comparative data against which population parameters in reintroduced populations may be assessed.
- In 2007 and 2008, very few dibblers have been captured in Peniup. The recovery team has supported the release of 40 dibblers in Peniup in October 2008, including all available zoo-bred animals supplemented by dibblers from FRNP.
- In February 2007, two new dibblers were captured in the monitoring grid on the release site. Hair trapping in areas adjacent to the monitoring grid also detected the presence of dibblers. Another release, of 40 captive-bred dibblers was carried out in October 2007. However in two monitoring sessions since then, no newly released dibblers were captured. The recovery team decided not to release further dibblers in FRNP in 2008 but concentrate on the Peniup translocation as it had been more promising. Monitoring by trapping and hair-funnels will continue in SRNP in 2008/2009.
- Dibbler surveys in FRNP in 2007/2008 have moved to the use of large numbers of hair-funnels placed along tracks within FRNP. Two surveys were carried out in the Wilderness Area of the FRNP. Previously unknown dibbler colonies were discovered in several areas, both within and outside the Wilderness Area. Surveys in spring have proved much more successful than at any other time of year. These surveys will be continued in 2008/2009.

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 existing FRNP and Jurien Bay island populations will continue.
- Baiting trials using rhodamine-labeled non-poisonous mouse baits and dead mice will be carried out on Boullanger and Whitlock Island, given AEC approval.
- The study of dibbler distribution in the FRNP will continue in 2008/2009, with survey activity focused on spring-early summer period.
- Dibbler surveys will be continued eastwards in 2008/2009, especially between Hopetoun and Esperance.

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# 1996/008

Team members

T Friend (0.75), S Hill (1.0), V Hack (0.5), L. Bell (0.5), S Schreck (0.5); T Button (0.1): Total (3.35).

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 2008.

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

- Ten animals have now been transferred from the Mount Gardner population via captivity to Bald Island, including two in August and one in December 2007. Six field trips were carried out during 2007/2008. During the most recent field trip, in April 2008, 18 potoroos were captured, including seven of the founders and 11 animals born on the island. It is likely that the goal of a population of 20 animals, to be achieved before animals are removed from the island for other recovery work, has been achieved.
- 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 2006-2007, 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 colony now comprises 31 long-nosed potoroos. To date, five Gilbert's potoroo pouch young taken from the wild have been cross-fostered to long-nosed potoroos in this facility and two have survived to weaning. The same surrogate mother was used in both successful transfers, suggesting that the temperament of the individual foster mother could be the most important factor in success. Trials will continue in 2008/2009, before a review of the program in 2009/2010.
- 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 non-breeding captive animals currently being held in the captive colony at Two Peoples Bay. The construction of the fence was funded by a grant from the Foundation for Australia's Most Endangered Species (Inc), in a project that will determine whether non-breeding captive animals will breed if given access to natural habitat and food. A male and a female were transferred to a cage within this area in October 2007 then transmitted and released into the larger area in November 2007. They were still being fed in the cage but moving freely outside when the male, an eight-year-old animal, died. He was replaced with a wild male from Mount Gardner, in a trial that will test whether the female is able to breed, on the assumption that the wild male is reproductively competent.
- Regular trapping of the Mount Gardner population, which occurs every four months, has taken on extra importance as it is vital that the impact of removing animals for Bald Island is closely monitored. During 2007/2008, high numbers have been recorded, with a record 25 animals captured in November 2007 (when the 10th potoroo was removed from Mount Gardner for Bald Island) and 18 in March. It appears that the removal of potoroos for translocation has had no negative impact.
- A 380 hectare fox- and cat-proof enclosure at Waychinicup National Park has been constructed.

- A search for a site for a future translocation of Gilbert's potoroos west of Albany, in a higher rainfall zone than Two Peoples Bay, was carried out with SOS funding. Thirteen sites in Frankland District were evaluated by assessment of vegetation structure, small mammal fauna, and species richness of hypogeal fungi assessed by examining the feces of mycophagous mammals. Three sites were selected as the most promising to date.

Management implications

- Results of the Bald Island translocation and subsequent monitoring indicate that a new self-sustaining population has been established, at a site unaffected by introduced predators and lacking most native predators. This new population will provide security for the species in the face of the greatest threat to its survival, wildfire at Two Peoples Bay.
- 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.
- Continue the cross-fostering trial.
- Modify the captive diet based on truffle analysis.
- Monitor the introduction of a male and a female potoroo into the 14 ha fenced enclosure.
- Eradicate foxes and cats from the Waychinicup NP enclosure and introduce Gilbert's potoroos from Bald Island and Mount Gardner. Monitor establishment of Gilbert's potoroos within the enclosure.
- Evaluate further translocation sites, both on the mainland and on other islands. In particular, continue 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# 1993/163

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 2006/2007.

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 two PhD students working on the Western barred bandicoot wart-like virus disease on an ARC Linkage Grant.

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 2008/2009.
- 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 2008/2009.

DEC Region

Midwest.

IBRA Regions

Geraldton Sandplains, Carnarvon.

NRM Regions

Rangelands, Avon.

Disease screening and vectors of transmission in quokkas (*Setonix brachyurus*) on the mainland and Bald Island

SPP# not yet allocated

Team members

T Friend (0.05).

Context

During studies of blood parasites of Gilbert's potoroos, trypanasomes (*Trypanosoma* sp.) and piroplasms (*Theileria* sp.) were discovered both in potoroos and in quokkas. This led to a PhD project by J Austen to examine epidemiology of these haemoparasites in geographically dispersed populations of quokkas. This will include the determination of the vectors involved in transmission. In conjunction with this study, quokkas will be radio-tracked on Bald Island and the mainland to determine patterns of movement and juvenile dispersal in the context of disease transmission and dissemination.

Salmonella has been shown to have a profound effect on the biology of the Rottnest quokka. It has been recorded in Bald Island quokkas but little is known about the species present or their

prevalence throughout the year. Quokkas are swabbed when captured and the samples plated up in Albany and sent to Perth for identification.

This project is being carried out at little extra cost during Gilbert's potoroo fieldwork. Quokkas are trapped during monitoring of Gilbert's potoroos on Bald Island and can be captured readily at mainland potoroo sites.

Aims

- To determine the infection rates and vectors of two blood parasites in quokkas in Bald Island and mainland populations and to identify vectors and possible rates of transmission.
- To determine infection rates, seasonality and species composition of Salmonella in quokkas on Bald Island and the south coast mainland.

Summary of progress and main findings

- Nesting home ranges of quokkas on Bald Island have been mapped and over 200 individual quokkas captured. Dispersal of young away from their natal area has not been recorded and it appears that quokkas remain faithful to their natal or family home ranges on Bald Island as on Rottnest.
- Blood samples have been taken from quokkas on Bald Island and the mainland and trypanosomes have been recorded and cultured from quokka blood.
- A paper was presented at the Australian Mammal Society meeting in Armidale, NSW, in July 2007 entitled "The Quokkas of Bald Island: Population biology and spatial organization".

Management implications

Understanding disease dynamics, especially modes of transmission, in wild populations is an important precursor to intensive management actions like reintroductions and top-up translocations.

Future directions (next 12-18 months)

- Continue to trap, sample and radio-track quokkas on Bald Island and Mount Gardner, Two Peoples Bay.
- Work with Murdoch University collaborators to further studies of blood parasites in quokkas.

DEC Regions

South Coast

IBRA Regions

Jarrah Forest.

NRM Region

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 2001/2002.
- 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 (0.05) Total (0.05).

Context

There is 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. Wambengers were found to be unaffected by the 3 mg 1080 Probaits in the field and so operational use of this bait type in all Western shield operations proceeded.

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.

Summary of progress and main findings

- None currently.
- 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# 2000/014 (incorporates 99/018)

Team members
N Marlow (0.05) Total (0.05).

Context
Previous research revealed that the uptake of Probaits was equal to that of dried meat baits. Longevity trials were undertaken with non-toxic baits. Fox control at Dryandra has been found to be less effective than predicted. A possible reason for this may be a loss of 1080 from baits. Trials now need to be undertaken to assess whether the 1080 content of baits decreases to a non-lethal level between baiting sessions.

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

Aim
To ensure that Probaits contain a lethal dose of 1080 for fox control between baiting sessions

Management implications

- Probaits need to contain sufficient 1080 to ensure that fox control is maintained.
- Future directions (next 12-18 months).
- Repeat previous longevity trials but use toxic baits with known concentrations of 1080 for analyses.
- 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 (0.85), A Williams (0.90), N Thomas (0.9), B Macmahon (1.0), J Lawson (0.1); Total (3.7).

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) are being investigated. Survival (#KTBA) will be measured as a function of fox abundance, cat abundance, and several other variables. Woylies are 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 150 individuals have been captured. The results of autopsies and DNA analysis of saliva on collars have indicated that fox predation continues to be an issue.
- 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. The baiting regime in the northern half of Dryandra Woodland is being increased in intensity and frequency. The 1080loading of baits is being increased from 3mg to 4.5 mg.
- The effectiveness of the current baiting regime at controlling foxes will be tested when radio-collared individuals are exposed to toxic baiting campaigns.

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 relisted 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# 1993/053

Team members
K Morris (0.25), J Jackson (0.40); Total (0.65).

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 five 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 three of the five 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 Service KRA 4 (conservation of threatened species), specifically Nature Conservation Service 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.
- Chuditch population located at Forrestania (Western Areas mine site) in Goldfields woodlands, perhaps the most eastern known population.
- Recovery plan revised after conservation status review concluded that chuditch should remain listed as Vulnerable.
- Participation in a national quoll conservation workshop convened by WWF (Australia).
- 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, recovery plan revised.

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 Island (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 two 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 to Wallabi Islands undertaken in January 2008 to collect tissue for DNA comparison with North Island population.
- Lethal cull on North Island commenced in August 2007.

Management implications

- Report on the lethal cull required.
- Restoration of over-grazed and over-browsed vegetation on North Island needs to be monitored.

Future direction (next 12-18 months)
Ongoing vegetation monitoring.

DEC Region
Midwest.

IBRA Region
Geraldton Sandplains.

NRM Region
Northern Agricultural.

Monitoring of mammal populations on Barrow Island

SPP# 2000/012

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 Service 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
- Monitoring undertaken in September 2007, including disease screening.
- 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).
- Paper on spotlighting results submitted to Australian Mammalogy.

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 April 2009.
- 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, J. Jackson 0.60, 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 2006/2007#3), and contributes to maintaining and developing a strong research program based on both in-house capacity and enhanced partnership (Corporate Priorities special emphasis 2006/2007 #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
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 updated – 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. Relationship between fox activity and fox numbers established. Cat activity remains higher at Lake Magenta.
- Probait uptake trails completed – less bait uptake at Lake Magenta, some evidence of bait avoidance.
- Bait uptake off track (in dense vegetation) less that on track.

- Vegetation assessments of trapping grids and sand plots completed.
- 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 February 2008, and the IA CRC in April 2008.

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 impact of simultaneous aerial and ground baiting on fox activity 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.

Rangelands Restoration – reintroduction of native mammals to Lorna Glen

SPP# CP to be prepared

Team members

K Morris (0.35), J Dunlop (1.00), Kalgoorlie Regional staff.

Context

Operation Rangelands Reconstruction commenced in 2000 with the acquisition of Lorna Glen and Earaheedy pastoral leases by the Western Australian Government. This 600 000 ha area lying across the Gascoyne and Murchison IBRA regions is now the site for an ecologically integrated project to restore rangeland natural ecosystem function and biodiversity. An important component of this is the reintroduction of 11 arid zone mammal species following the successful control of feral cats and foxes.

The area now comprising Lorna Glen once supported a diverse mammal fauna that was representative of the rangelands and deserts to the north and east. These areas have suffered the greatest in terms of mammal declines in Western Australia. The original vision for the Western Shield fauna recovery program was to expand introduced predator control and translocations beyond the south-west once an operational feral cat control program had been developed, and this was also recommended by the independent review of Western Shield in 2003.

Potentially Lorna Glen could support one of the most diverse mammal assemblages in arid Australia, and contribute significantly to the long-term conservation of several threatened species. Mammal reconstruction in this area will also contribute significantly to the restoration of rangeland ecosystems through activities such as digging the soil and grazing / browsing vegetation, and assist in the return of fire regimes that are more beneficial to the maintenance of biodiversity in the arid zone. Once populations have established, there will also be considerable potential for students and other researchers to study arid zone mammal biology and ecology and related issues.

The first of the mammal reintroductions commenced in August 2007 with the release of ninu (*Macrotis lagotis*) and wayurta (*Trichosurus vulpecula*). Another nine species of mammal are proposed for reintroduction over the next 10 years.

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 reintroduce 11 native mammal species to Lorna Glen over the next 11 years.
- To re-establish ecosystem processes and improve the condition of a rangeland property.
- To improve the conservation status of some threatened species.
- To develop and refine protocols for fauna translocation and monitoring.

Summary of progress and main findings

- 46 ninu (bilby) and 71 wayurta (brushtail possum) reintroduced to Lorna Glen.
- Intensive monitoring undertaken and causes of mortality identified. Initial bilby mortality was due primarily to cat predation, but this ceased after animals were moved to another release site. A low level of early possum mortality was due to lack of food and shelter resources.
- 30 sites established to monitor extant fauna and vegetation condition response to management activity.
- Progress report prepared.
- Translocation Proposal and AEC approvals gained for mala reintroduction in September 2008.

Management implications

This project will contribute to the management and improvement of DEC's rangeland properties and provide guidance for future fauna reconstruction, e.g Dirk Hartog Island. It will also demonstrate effective partnerships with traditional owners.

Future directions (next 12-18 months)

- Restock with bilbies in August 2008.
- Translocate mala in September 2008.
- Undertake intensive monitoring of mala.
- Plan for boodie and golden bandicoot translocations in 2009.
- Seek Caring for our Country funding.

DEC Regions

Goldfields

IBRA Regions
Murchison, Gascoyne.

NRM Regions
Rangelands.

Ecology and conservation of threatened pythons in WA

SPP# 1993/159

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 three 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# 1999/011

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 Service KRAs 4.1, 6.1 and 6.3.

Aims

- To implement the Lancelin Island skink (LIS) Recovery Plan, 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 five years 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 Service KRAs 3.11, 4.1 and 6.1.

Aims
- Prepare a recovery plan for the five 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 Service KRAs 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 2008 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 2008
- 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 2008-9 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# 1993/040

Team members

B Prince (0.75), K Morris (0.10); Staff from Denham, Exmouth, Karratha and Broome; Total (0.85).

Context

Six species of marine turtle are known in Western Australian waters, all are listed by both State and Commonwealth as threatened, five of these (green, flatback, olive ridley, hawksbill, and loggerhead) are known to breed in Western Australia.

This project aligns with Nature Conservation Service 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

- Integrated tagging database developed and provided to
- 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 nesting beach temperature profiles.

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

Future directions (next 12-18 months)

- Liaise 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 DEC 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# 2003/002

Team members
N Thomas (0.1), N Marlow (0.05); Total (0.15).

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 (RtD) project was established to investigate the best methodology to captively breed and maintain five 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 five critical weight range (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. A release of Boodies into Dryandra Woodland was not successful. A release of boodies to Lorna Glen is planned.
- Sightings and capture of wild born Dalgytes within Dryandra Woodland proper indicate that they have established well, albeit in low numbers.
- 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.
- The -identity of the 'wart-like' syndrome pathogen infecting Western barred bandicoots has been confirmed. No further procurement of marl for RtD enclosures is planned.
- Dalgyte numbers in the RtD enclosures were manipulated to investigate whether Dalgytes were impacting on Marl recruitment. Marl recruitment appeared to increase when dalgytes were removed.

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.

Future directions (next 12-18 months)

- Determine if dalgyte translocation in Dryandra Woodland has met criteria for success.
- Continue with translocation of Dalgytes and possibly boodies to Lorna Glen.

DEC Region

Wheatbelt.

IBRA Region

Avon Wheatbelt.

NRM Regions

South West, Avon.

Feral camel surveys in the interior of WA

SPP# not allocated (BCI project)

Team members

B Ward (0.10), G Liddelow (0.10), C Ward (0.10); Total (0.30).

Context

There is evidence that the Australian feral camel population has doubled over the last 8-10 years, with some estimates of the population being put as high as 1 million camels. About half of this population is thought to be in Western Australia. There is growing concern that feral camels are now having deleterious impacts on the environment, on pastoral and community infrastructure and on cultural values. In addition, there continues to be interest in the commercial utilization of camels for meat and other purposes. In order to make informed decisions about the likely impacts of feral camels and their management, it is necessary to have an understanding of the density and distribution of feral camels in Western Australia and of their movement patterns, population dynamics and impacts.

Aims

To quantify the distribution and density of feral camels and other pest animals including donkeys, wild horses and wild cattle in the interior of WA as a basis for assessing environmental,

infrastructure and cultural impacts and for developing cost effective control strategies.

Summary of progress and main findings

- About 40,000 km of transect covering about 260,000 square kilometers have been flown, comprising parts of the Great Sandy Desert, Little Sandy Desert, Gibson Desert, Murchison, Great Victoria Desert, Central Ranges and Nullarbor biological regions.
- While the survey program and data analysis are incomplete, early indications are that there are about 400,000 feral camels in Western Australia. The camels are not evenly distributed throughout the interior, but are clumped in their distribution. Large breeding herds of up to 100 animals are often found in the more productive parts of the landscape such as along river systems, lakes and ranges. In dry conditions in the less productive areas such as sand plains and dune fields, camel densities are considerably lower and are usually solitary old bulls or small bachelor herds of 2-5 animals.

Management implications

- Informed risk assessment of the threat posed by feral camels.
- Data provide a basis on which to devise cost effective control programs including aerial culling operations.

Future directions (next 12-18 months)

- Further surveys planned for the next 1-2 years will sample the southern part of the Kimberley region, giving good coverage of the State and enabling a reliable estimate of camel densities and distributions to be made.
- Furthermore, these surveys provide valuable baseline data prior to any management activity and provide information about which land systems and vegetation types are most at risk from feral camels.

DEC Regions

Goldfields, Midwest, Pilbara, Kimberley

IBRA Region

Nullarbor, Great Victoria Desert, Gibson Desert, Central Ranges, Gascoyne, Murchison, Little Sandy Desert, Great Sandy Desert, Tanami, Ord Victoria Plains, Central Kimberley.

NRM Region

Rangelands.

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

SPP# 2002/002

Team Members

A Wayne (0.1), C Ward (0.0), C Vellios (0.0); Total (0.1).

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 two species as potentially the most susceptible medium-sized mammals to jarrah forest timber-harvesting.

This study aligns with Corporate Priorities with special emphasis for 2005/2006 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.
- Five Scientific papers published and two scientific papers in review for publication.

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 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.
- 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.

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# 2007/002

Team Members

A Wayne (1.0), C Ward (1.0), C Vellios (1.0), M Maxwell (1.0), G Liddelow (0.05), B Ward (0.05); Total (4.1).

Context

The woylie declined by 70-80% between 2001 and 2006. The declines are continuing with no clear signs of a recovery. By mid 2008 it is predicted that the species will have declined by at least 80% to less than 8,000-10,000 individuals. The rate of decline in affected populations has been rapid; up to 95% per annum. The largest and most important populations have been most severely affected. Examples include the last remaining indigenous populations of Dryandra (93% decline) and Upper Warren (95% decline), and the largest translocated populations of Batalling (97% decline) and Venus Bay Peninsula, South Australia (>90% decline). In January 2008, the Western Australian State Government re-listed the woylie as "fauna that is rare or is likely to become extinct" (Schedule 1, Wildlife Conservation Act 1950). The cause(s) for these declines remains unknown.

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

- The Population Comparison Study (PCS) has identified key distinctive differences between woylie populations at Karakamia (which has not declined), and Upper Warren (where substantial declines have occurred) that may relate to the cause(s) of declines. These include;
- Toxoplasma has not been detected in woylies at Karakamia, but has been detected at Upper Warren.
- Trypanosoma is common in the Upper Warren woylie populations (43% prevalence). It has recently been detected at Karakamia, albeit at very low infection levels and prevalence rates relative to the Upper Warren woylie populations.
- Karakamia is effectively free from introduced predators. Cats and foxes are present at Upper Warren.
- Biometric and morphometric data indicates that the high density woylie population at Karakamia, although stable, is very likely resource-limited, in contrast to comparative data from Upper Warren populations, which do not appear resource limited.
- Several new species and discoveries have been made as part of the WCRP. These include;
- New species of ectoparasite, endoparasites, haemaparasites, and hypogeal fungi
- New host-parasite associations previously not described
- Evidence of vertical transmission in woylies of Toxoplasma from mother to pouch-young.
- Establishment of the Woylie Conservation Steering Group (WCSG) to oversee, co-ordinate and support research and management endeavors to identify the causes of the recent woylie declines and improve the conservation outcomes for the species.
- Establishment of the Woylie Disease Reference Council (WDRC) comprised of expertise from Murdoch University and Perth Zoo.
- Established a central relational database for fauna in the Upper Warren, including 25,479 woylie records since 1974 to December 2007 created by the aggregation of multiple, previously isolated datasets.
- Produced a field operations handbook providing details on the methodology and protocols for the WCRP, which are also relevant and/or used as part of other DEC activities (monitoring and

research).

- Standarded and synchronized separate, independent fauna monitoring activities in the Upper Warren region.
- Delivered Wildlife forensics course and workshop for DEC and WCRP collaborators.

Management Implications

- Refer to the Progress Report (final draft) released in January 2008.
- Refer to Research, monitoring and management recommendations presented in the Progress Report (2008).
- Establish woylie recovery team and recovery plan.
- Federal conservation status review.
- Phase two research proposal prepared for endorsement and funding.
- Western Shield operations- predator control, translocations, monitoring.
- Wildlife Disease risks, management and hygiene protocols.
- Corporate Standard Operating Procedures and Protocols - clear, improved, user friendly
- Fauna data management – database centralization, up-to-date maintenance, data quality control etc – all critically important for providing fundamental information on population changes and emerging conservation and management issues and providing the primary source of information to assist in determining the causes of declines of woylies and any other native fauna.

Future directions

- Funding for Phase 1 is now complete. Publication of results to date will be forthcoming.
- Phase two proposal has been developed and requires endorsement and funding.

DEC Region
Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

Conservation of Western Australian butterflies

SPP# 1993/022

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

Context
Invertebrates constitute a major part of the State's biodiversity. 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 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

- Paper on methods of surveying for butterflies and day-flying moths in Western Australia in press, Environmental Entomology.
- Report submitted to Native Vegetation Conservation branch on the likely effects of vegetation clearing on the rare butterfly Ogyris subterrestris petrina.
- Proposal to list Ogyris subterrestris petrina as critically endangered butterfly submitted to TSSC.
- Further surveys of potentially endangered O. subterrestris petrina completed.
- Paper on patterns of species richness of butterflies and day-active moths in a fragmented urban landscape submitted to Pacific Conservation Biology.
- Paper on diversity-habitat relations of diurnal Lepidoptera in urban habitat fragments submitted to Austral Ecology.
- Paper on fitting and comparing alternative models of the species-area and species-area-habitat relation completed.
- Paper on factors affecting incidence of butterflies and day-active moths in a fragmented urban landscape completed.
- Paper presented at MEDECOS conference on patterns of species richness of butterflies and day-active moths in a fragmented urban landscape.

Management implications

- More than 10 butterfly species are now locally extinct in the highly disturbed bushland remnants on the Swan Coastal Plain (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 threatened vertebrates, will be necessary to maintain butterfly biodiversity of the SCP.

Future directions (next 12-18 months)

- Work on the arid bronze azure, a proposed critically endangered butterfly, and the graceful sun moth.
- Finalize project on conservation of butterflies and day-active moths in urban habitat fragments.

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# 2004/001

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 SCP, 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 SCP.
- 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

- Field work completed in 2007.
- Limited sorting and identification done.

Management implications

Development of an appropriate conservation strategy for earthworm fauna on the SCP based on a dynamic ecosystem perspective.

Future directions (next 12-18 months)

- Continue identification of specimens.
- Prepare papers for publication

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# 1998/003

Team members

M Byrne (0.3), D Coates (0.2), N Gibson (0.05) B Macdonald (0.5), S McArthur (0.1); Total (1.15).

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 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 *Banksia mimica* and *Pultenaea pauciflora* to assist in the taxonomic revision of the group
- To determine the hybrid status of *Eucalyptus stoataptera*.
- To determine the mating system in populations of *Grevillea curviloba*.

Summary of progress and main findings

- *Synaphea* sp. – AFLP genotypes have been obtained for 25 populations representing eight 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 have been obtained and are being are being tested.
- *Calothamnus quadrifidus* – cpDNA analysis of 40 populations throughout the range from Shark Bay to Esperance has shown differentiation of two lineages.
- *B. mimica* – genetic differentiation between the Whicher Range and Wattle Gove/Mogumber populations is substantial and warrants their recognition as separate taxa.
- *P. pauciflora* – AFLP genotypes have been obtained for six populations of *Pultenaea pauciflora* from the three areas, and data analyses to determine their genetic relatedness are currently being undertaken.
- Journal paper on *E. bennettiae* as a hybrid between *E. sporadica* and *E. lehmannii* has been submitted to Biological Conservation.
- Journal paper on development of microsatellites in *Banksia nivea* has been submitted to Molecular Ecology Resources.
- Journal paper on genetic structure in *E. caesia* has been published in Biological Journal of the Linnaean Society.

- Review on the phylogeny, diversity and evolution of eucalypts has been published in Plant Genome.
- Review of Pleistocene refugia in southern Australia has been submitted to Quaternary Science Reviews.
- Review of the evolutionary history of the Australian arid zone biota has been submitted to Molecur Ecology.

Management implications

- 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.
- Taxonomic revision and revised assessment of conservation status of *D. mimica* taxa is required.
- Clarification of the genetic relatedness of populations within *P. pauciflora* will determine whether the species can be removed from the DRF list.
- Assessment of mating system in *G. curvilloba* will determine whether any outcrossing is occurring among clones within the populations, or whether very low seed set is due to selfing of clones.

Future directions (next 12-18 months)

- Journal paper on the genetic status of the subspecies in *G. curviloba* 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 *C. quadrifidus* and allied taxa will be undertaken to inform taxonomic revision of the group.
- Hybrid status of *E. stoataptera* 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# 2002/001

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), N. Gibson (0.05) Total (2.55).

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.
- 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 three target taxa, *Calothamnus quadrifidus, Eremea pauciflora* and *Eucalyptus wandoo,* in the Dongolocking area of the wheatbelt, with varied ecologies to assess how life history affects the impact of remnant characteristics on population viability.
- Directly quantify patterns of pollen movement and seed dispersal for *Banksia sphearocarpa* in a highly fragmented 10 x 20 km area south of Harrismith in the south western Wheatbelt
- To assess the importance of gene flow to the reproductive output and population dynamics of patch populations of *Banksia sphaerocarpa* by quantifying the relative frequency of local vs immigrant mating events, and then comparing the fitness of resulting seedlings in growth trials as well as contrasting the overall demographic performance of high and low gene flow sites.
- To develop specific genetic and demographic guidelines for management of remnant populations of the target taxa and general landscape design principles for major plant life history types that will maximize the probability of population persistence.
- To develop an understanding of the population biology, mating systems and gene flow of flora with distributions centred on the seasonally wet Busselton ironstone communities to inform management for long term conservation in relation to population viability (population size and degree of connection) and appropriate fire frequency.

Summary of progress and main findings

- 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.
- Although significant connectivity is not apparent across large sections of the Dongolocking landscape high level of pollen movement (gene flow) into small isolated *C. quadrifidus* and *E. wandoo* populations from at least 1km is evident. A significant factor in ensuring gene flow between *C. quadrifidus* and *E. wandoo* populations in this landscape appears to be the presence of spatially critical paddock trees and small remnants.
- Phase 2 Assessing genetic connectivity (in *Banksia sphaerocarpa*) across a fragmented landscape Site selection for a *Banksia sphaerocarpa* gene flow study has been completed.
- 12 focus populations have been selected for assessing genetic connectivity in *Banksia sphaerocarpa*. There are eight small focus populations (population size range 12 - 61 adults) and four large focus populations (population sizes of several thousand adults. Within the large focus populations, a single ‘focus area’ has been identified, consisting of a cluster of 30 adult plants.
- 10 maternal plants from each of the 12 focus populations have been surveyed for flowering and reproductive output. Plants in small populations produced significantly more fertile cones per plant than large populations. Large and small populations produced similar numbers of apparently viable seeds per cone, insect damaged seeds and cone weights.
- A primer note describing eight SSR loci for *Banksia sphaerocarpa* has been submitted to Molecular Ecology Notes.
- Mating systems, reproductive biology, demography and gene flow among populations have been measured for two ironstone endemics *Calothamnus* sp. Whicher and *Hakea oldfieldii.*
- High levels of selfing were observed within populations of *Calothamnus* sp Whicher and genetic

differentiation between populations was high. Pollen dispersal among populations was very low, although some pollen dispersal was identified over 5 km consistent with bird pollination in the species.

- Population size had no impact on seed production in *Calothamnus* sp Whicher or *H. oldfieldii*
- Preliminary results presented to SWCC.
- Journal paper on pollen dispersal and genetic differentiation in *Calothamnus* sp Whicher submitted to Conservation Genetics.
- Low pollen dispersal indicates that fragmented populations of *Calothamnus* sp Whicher have little genetic connectivity. This may not have changed much from pre-fragmentation since high genetic differentiation indicates that the populations have been historically isolated and gene flow has been low. However, even if gene flow has been historically low and populations were historically isolated they are now much smaller so inbreeding is significant. Despite high levels of inbreeding there is currently no impact on seed production and most populations are recruiting seedlings where seasonal water inundation is still occurring and competition with weeds is low.

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 *Banksia sphaerocarpa* seed set/reproductive output studies.
- Complete *Banksia sphaerocarpa* genetic variation studies and gene flow studies.
- Write papers on: mating system variation and reproductive output in *Eremaea pauciflora*, genetic diversity in *E. wandoo* and genetic diversity in *C. quadrifidus*.
- Assess genetic diversity in *H. oldfieldii* and *D. nivea* ssp. *uliginosa*
- Assess pollen dispersal and mating systems in *H. oldfieldii* and *D. nivea* ssp. *uliginosa*
- Complete investigations of reproductive biology and demography in *H. oldfieldii* and *D. nivea* ssp. *Uliginosa.*

DEC Region

Wheatbelt, South-west.

IBRA Region

Avon Wheatbelt, Swan Coastal Plain.

NRM Regions

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

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

- Draft paper in preparation on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis* subsp*. Fimbrilepis*'.
- Microsatellite genotyping of 13 extant and five extinct populations of *Banksia brownii* completed and data analysis commenced

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*.
- Submit for publication a paper on genetic structure and the impact of localized extinction on genetic diversity levels in *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# 1999/010

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 by collecting and storing seed of rare and threatened Western Australian plant species.
- To provide a focus for flora recovery in Western Australia.
- To increase knowledge of seed biology, ecology and longevity through describing seed, gathering phenological data, ,conducting field-based seed ecology investigations, , determining seed germination and storage requirements, and monitoring seed viability in storage.
- 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 were made from 288 rare, threatened, poorly known and other taxa (428 accessions). This includes 198 DRF, 167 Priority and 63 general collections associated with threatened ecological communities and biodiversity hotspots.
- Duplicate material of 123 collections was sent to the Millennium Seed Bank Project in the UK for safe keeping.
- Seeds of seven species collected and stored by the TFSC have been used in translocations in the past year.
- Collection, testing, storage and monitoring information is accessible in WASEED database.
- *Landscope* article published describing seed conservation achievements.
- Population demography and seed bank dynamics of *Grevillea maxwellii* published in *Journal of the Royal Society WA.*
- Response of the germinable soil-stored seed bank of a remnant reserve in the southern Western Australian agricultural zone to smoke and fire treatment published in *Journal of the Royal Society WA*.
- How will warming temperatures affect recruitment of southern Western Australian narrow range mountain endemics? published in *Australasian Plant Conservation.*

Management implications

Improved conservation of threatened and endemic WA flora.

Future directions (next 12-18 months)

- Ongoing seed collection for conservation, including DRF and priority taxa, and common species associated with threatened ecological communities and biodiversity hotspots.
- Ongoing research into seed biology and seed storage behaviour of threatened plant taxa.
- Germination testing, storage and monitoring of existing collections.
- Continue Phase 2 of international collaboration with Millennium Seed Bank (MSB) Project and provide report on progress to MSB.
- Complete final report to South Coast Natural Resource Management Inc.
- Continued research into germination temperature thresholds for south west Western Australian taxa.
- Publish results of preliminary germination temperature profiles for Stirling Range species.
- Completion of Andrew Crawford's PhD and associated papers.

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 # 1997/002

Team members

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

Context

Understanding the nature and extent of introduced plants in native and agricultural systems of Western *Australia*. These data are used 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

- Western Weeds 2; a field guide to the Weeds of Western Australia published; 5,500 copies of previous edition sold.
- Proceedings of Sharp Rush Symposium Published.
- NRM grant for Strategic weed management in Swan NRM Region. Report completed and weeds prioritized for region presented in databased format to region.
- Presented and participated in DEC Weed Training Workshop at Busselton in November 2007.

- Note detailing potential weed problems in *Lomandra longifolia* and notes on *Oxalis corniculata* published in WA Wildflower Society Newsletter.
- State member of national Willows Working Group.
- Continue on assessment panel for remote weed projects by fire crews.
- Presented and produced review of Geraldton Carnation weed for DEC 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)

- 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.
- Paper on Bulbous weeds accepted for International weeds symposium.
- Complete Kimberley Woody Weeds Survey (already three new weed records for WA).

DEC Regions

All.

IBRA Regions

All.

NRM Regions

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

Experimental translocation of Critically Endangered plants

SPP# 2001/004

Team members

L Monks (0.6), R. Dillon (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 six Critically Endangered plants were completed involving the establishment of new populations at two sites for each species as part of stage 2 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 of study on *Lambertia orbifolia* translocation success, commenced writing paper of Acacia translocation success.

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)

- Commence stage three of the translocation of 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* translocation data, 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.

Ecophysiology of rare flora restricted to shallow-soil communities

SPP# not yet allocated

Team members

P Poot (0.5).

Context

The South West Australian floristic region is recognized as one of only 34 global biodiversity hotspots: those regions on earth richest in endemic species under threat. Approximately 2 000 of a total of 8 000 plant species in SW Australia occur on granite outcrops or other shallow-soil environments. Many of these species are shallow-soil endemics that have a highly scattered and often restricted distribution. Also worldwide a large number of rare species occur in open, shallow, rocky and drought-prone environments. This suggests that shallow-soil endemics may have special adaptations to their own habitats that prevent them from establishing and being competitive in others.

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

This project will greatly enhance our knowledge of the key adaptations of the species endemic to shallow-soil habitats, and how these adaptations may restrict them in their distribution. Such knowledge provides the essential framework for future management.

Summary of progress and research findings

- Compared to four of their common congeners, *Hakea* species near-endemic to critically endangered ironstone communities (i.e. *H. oldfieldii*, *H. tuberculata*) invest more biomass in their roots as young seedlings and have a different root system morphology. The ironstone *Hakea* species invested less in cluster roots (i.e. bottlebrush-like structured that are involved in nutrient mobilization and uptake), formed more deep roots and showed considerable more lateral spread of their root system. This specialized root-system morphology presumably increases their chance to locate cracks in the underlying rock and could potentially explain their success in their own habitat as well as their failure in others.
- Results of a reciprocal transplant experiment with young seedlings showed that ironstone species have much higher summer survival in their own habitat then their common congeners. However, also in several non-ironstone habitats the ironstone species survived.
- A paper on the above results was published in The New Phytologist and attracted an editorial commentary.
- Preliminary results with 'granite outcrop/non-granite outcrop' congeneric species pairs showed similar shallow-soil specializations: species endemic to granite outcrops either invested more biomass in their roots or showed a faster lateral root spread then their non-granite outcrop congeners.
- A large ARC linkage proposal (with UWA, Murdoch University, BGPA, Extension Hill Pty Ltd, Mt Gibson Mining Ltd) has been submitted to study the biology, conservation and restoration ecology of shallow-soil endemics in Banded Ironstone Formation (BIF) habitat. This proposal includes ecophysiological work on two BIF endemics.

Management implications

- Revegetation/replanting of perennial vegetation in shallow-soil communities can only be expected to be successful when there are cracks 'available' to the plants' roots in the underlying rock. This may only be the case after fire or after the death of mature individuals. Also, relatively bare areas with low native vegetation cover are unlikely to be useful for revegetation purposes (i.e. they are bare for a reason: low water supply).
- Using glasshouse grown seedlings with relatively few and often stunted and air pruned roots may be especially problematic for revegetation purposes on shallow soils. A high investment in roots appears essential for first summer survival and glasshouse grown seedlings often have much higher shoot to root ratio's.
- Watering over summer may greatly increase survival of transplanted shallow-soil endemics as individuals that did not reach cracks with sufficient water supply before summer get another chance. However, long term establishment will be dependent on obtaining a more permanent access to the rocks water supply.

Future directions (next 12-18 months)

- Continue research on shallow-soil endemics (through UWA Honours and PhD students).
- Start eco-physiological work and a more scientific approach in DRF translocations to better understand (1) the physiological adaptations of rare plants to their particular habitats and (2) the reasons for success and/or failure of translocations.

DEC Regions

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

IBRA Regions

Swan, Warren, Avon Wheatbelt, Jarrah Forest, Esperance Plains.

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

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

SPP# 1993/068

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

- Draft paper written on the influence of jarrah forest sites and south coast sites on phosphite effectiveness.
- Inter-specific differences in phosphite effectiveness within *Lambertia* tested by soil inoculation. Phosphite effectiveness depended on timing of phosphite application in relation to inoculation.

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# 1999/019

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 119 taxa for susceptibility in 2008.
- To date 50+ taxa transferred to pots for testing in 2009.
- 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 2008.
- Inoculate plants in 2009 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

- Seasonal monitoring of pathogen population dynamics is now complete. Data collation and statistical analysis is now underway.
- Assessment of the conduciveness of South Coast soils to *P. cinnamomi* infection is now complete. Soils from Gull Rock National Park and the Stirling Range National park were highly conducive. The soils collected from the areas surrounding the Bell Track infestation in the Fitzgerald River National Park varied significantly in their conducive ability with some soils highly suppressive, intermediate and some highly conducive. The results can be used to model disease impacts in the areas surrounding the current infestation at Bell Track.
- Ongoing monitoring of spatial variation in the soil population dynamics of *P. cinnamomi*.
- On-going monitoring of the efficacy of the High Intensity Phosphite application at 3 locations in the South Coast region.

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 variation in the soil population dynamics of *P. cinnamomi.*
- Investigation of the apparent tolerance of surviving susceptible plant species in infested areas.
- Monitor the efficacy of high intensity phosphite to prevent disease centre extension and minimize the impact of *P. cinnamomi*.
- Investigation into the efficacy of phosphite in controlling newly described Phytophthora species from the south-west of Western Australia.
- Publication of the research findings from the project conducted between 2006-2008.

DEC Region
South Coast.

IBRA Region
Esperance Plains.

NRM Region
South Coast.

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

SPP# 1993/112

Team member

M Stukely (0.05).

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. 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 has been published. .
- A journal paper on the results of a trial of grafting for the propagation of DRJ (SPP# 1995/014; NHT Project 003072 – 'Producing Dieback Resistant Jarrah for land and forest rehabilitation') has been submitted and its revision completed for publication.
- A journal paper arising from the PhD project of M Wheeler (Murdoch University) was completed and is currently under revision: 'Intraspecific variation in seed viability and seed production in clones and wild trees of *Eucalyptus marginata* (Myrtaceae)' . Two posters from this project were presented at "Seed Ecology II" - The 2nd International Society for Seed Science Meeting on Seeds and the Environment, Perth, WA, 9-13 September 2007.

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 20 years.

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 crops have been collected from the orchard (FPC) in 2006-07 and 2007-08.

Management implications

Now that seed production has started in the seed orchard, DRJ seedlings can 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. The first public release of DRJ seedlings was made in the 2007 planting season. 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 maintained with a low level of activity [the field trials will be retained for long-term monitoring].
- Infill planting of DRJ Seed Orchard at Manjimup Plant Propagation Centre 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# 1994/006

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# 1993/112). Seedling DRJ are now available for operational plantings as the DRJ seed orchard (SPP# 1993/112) 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# 1993/112), 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, using 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 three 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.
- Advice and assistance has been given for the newly established Black Gravel research project being conducted by Vicki Stokes.

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# 1993/112) 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 maintained with a low level of activity [the field trials will be retained for long-term monitoring].
- Advice will be provided on the design and treatments for a final trial to be set up by Alcoa and DEC to determine the combination of treatments for optimum jarrah seedling survival for operational plantings 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.

Hanold and Randles (University of Adelaide) have continued searching for a pathogenic cause for MY; they had earlier reported distinctive MY-RNAs that showed promise as a potential molecular marker for diagnosing MY in affected trees, but these RNAs have now also been found in healthy trees. However, they have recently discovered a specific protein marker in the leaves of MY-affected trees, along with virus-like particles. We are collaborating with these continuing investigations. Meanwhile, investigators in Victoria (Czerniakowski *et al.*) have concluded that MY is caused by abiotic soil factors, particularly the accumulation of carbonate and bicarbonate in alkaline soil inducing deficiencies of iron and other micronutrients (i.e., 'lime chlorosis') in trees. However, in WA there are numerous sites where typical MY symptoms occur in trees on pH-neutral and acid soils. Treatment with iron implants has apparently corrected the foliar yellowing symptom of MY-affected trees on alkaline soils, but this effect is often only temporary and dieback then continues.

Once the cause(s) of MY, its 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 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.
- 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 potential diagnostic molecular 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 from Northampton to Esperance. They occur on disturbed sites including roadsides, parks and gardens, and symptoms have also been observed in remnant individual paddock trees and woodlands 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. Diseased and apparently healthy trees can grow alongside each other.
- A conference paper has been prepared (for presentation by Prof J Randles) at the *Second International Symposium on Guava and other Myrtaceae*, Merida, Mexico, 10-13 November 2008.
- 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(s), 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 from WA sites for publication.
- Harvest foliar material from seedling transmission trials in the glasshouse for testing for molecular markers.
- 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 (0.25), J Webster (0.6), J Ciampini (0.4); Total (1.25).

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 *Phytophthora* Dieback

and other plant disease problems in parks and reserves, forests, plantations and nurseries.

Summary of progress and main findings

- A total of 2106 samples were processed for *Phytophthora* between July 2007 and May 2008, 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 nine new and undescribed *Phytophthora* taxa to be established in WA's natural ecosystems. They are all associated with dying native plants. A poster on these findings was presented at the 4th IUFRO Meeting on Phytophthoras in Forests and Natural Ecosystems, Monterey, California, USA, 26-31 August 2007.
- Another presentation is being prepared for the 3rd International *Phytophthora* and *Pythium* Workshop: "Integration of traditional and modern approaches for investigating the taxonomy and evolution of *Phytophthora*, *Pythium* and related genera" Turin, Italy, 23-24 August 2008.
- A paper reporting one of the undescribed taxa (*P*.sp.WA1) is in preparation for publication in *Australasian Plant Disease Notes*.
- Distribution maps of all *Phytophthora* taxa in south-west WA have been prepared from the VHS database with assistance from GIS section, and provided to FMB.
- A co-supervised PhD student project commenced in April 2007 at Murdoch University to investigate aspects of these new *Phytophthora* taxa:
- *Phytophthora inundata*, a recognized pathogen of woody trees and shrubs named in 2003 in the UK, has been isolated from dying native vegetation in WA. A journal paper reporting the first record of its isolation from Australian native vegetation was published in *Australasian Plant Pathology*.
- A presentation was given at the 2007 *Dieback Information Group (DIG) Conference*: 'New *Phytophthora* species in WA.'
- New records of other, named *Phytophthoras* occurring in WA native vegetation have also been obtained from samples tested: *P. asparagi, P. niederhauseria* and *P. gonapodyides*.
- Dr C Dunne has used the VHS facilities for the Biodiversity Conservation Initiative (BCI) – *Phytophthora* project. The services and facilities of the VHS were also made available to a PhD student project at UWA. Assistance has also been provided to V Stokes (Black Gravel project).
- An Annual Report on *Phytophthora* detection by the VHS in 2006-2007 was distributed within DEC. A comprehensive review of the VHS operations was prepared and submitted for approval as an unpublished DEC Report.
- Recommendations for managing the *Phytophthoras* other than *P. cinnamomi* were drafted and circulated to FMB for comment and 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 Phytophthora Dieback and 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 to develop appropriate strategies for their monitoring, management and control. It may not be appropriate to treat all Phytophthoras in the same way as *P. cinnamomi.* All of the undescribed *Phytophthora* taxa have been associated with dying native plants in WA, which is a clear indication that they have pathogenic capability in natural ecosystems.

- 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.
- Continuing 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), and *Project Dieback*.
- 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.sp.WA1. Conference posters will be presented.
- The draft recommendations (2007) for managing the Phytophthoras other than *P. cinnamomi* will be developed further.
- The *Phytophthora* Culture Collection and WA *Phytophthora* database will be maintained and expanded, and available to researchers.
- Supervision of the PhD student project (A 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 (0.5); Total (0.5).

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.
- Redefined population models and resumed population viability analyses (PVA) examining the effect of different fire regimes on the persistence of *Verticordia fimbrilepis* subsp. fimbrilepis populations in wheatbelt remnant vegetation.
- Began supervising a student project monitoring the impacts of successive fires and weeds on the population viability of the Critically Endangered *Calytrix breviseta* subsp. *breviseta* and composition of the associated plant community.

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* spp. *fimbrilepis* in habitat fragments.

Future directions (next 12-18 months)

- Continue to monitor the Fire Ecology of the Eastern Stirling Range Montane Heath and Thicket Community.
- Complete PVA modeling for *V. fimbrilepis* ssp. *fimbrilepis* and *C. breviseta* ssp. *breviseta*.
- Work with DEC Great Southern District to implement a fire management plan for *V. fimbrilepis* ssp. *fimbrilepis.*
- Work with DEC Swan Region to implement a fire management plan for *C. breviseta* ssp. *breviseta*.
- Begin supervising a student project examining the vulnerability of *Verticordia staminosa* ssp. *staminosa* to the impacts of climate change.

DEC Regions

South Coast, Swan, Wheatbelt

IBRA Regions

Avon Wheatbelt, Jarrah Forest, Esperance Plains.

NRM Regions

Avon, South Coast, Swan

Causes of rarity in four *Tetratheca* taxa in the Goldfields Ranges

SPP# 2000/015

Team members

C Yates (0.2), N Gibson (0.05), N Petit (0.15) Total (0.40).

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 three 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 describe and compare the physical environmental domains of the four BIF *Tetratheca* taxa and associated floristic assemblages to assist with identifying sites and techniques for translocation.
- To describe and compare the reproductive biology of the four BIF *Tetratheca* taxa and investigate how reproduction is influenced by climate.
- To describe and compare the population structures and demography of the four BIF *Tetratheca* taxa and estimate annual rates of demographic parameters.
- To construct models of population dynamics for exploratory investigation of the potential impact on population viability of further reducing the number of plants in the *T. paynterae* subsp. *paynterae* population and other disturbances.

Summary of progress and research findings

- Completed modeling of the physical environmental domains and associated floristic assemblages of the four *Tetratheca* taxa.
- Completed modeling of the species composition of upland plant communities on each of the ironstone ranges where the four *Tetratheca* taxa occur.
- Completed measurements of reproductive biology and demography of the four *Tetratheca* taxa.
- Completed modeling population dynamics and population viability analysis (PVA) investigating impacts of further reducing the number of plants in the *T. paynterae* subsp. *paynterae* population and other disturbances.
- Completed and submitted final report to Portman Iron Ore Ltd.

Management implications

- The geographic restriction of the BIF *Tetratheca* to single BIF ranges and the highly specific habitat, restrict options for translocating the taxa if habitat is destroyed by mining. The common practice of using seedlings grown either from seed or cuttings will not be suitable for three of the BIF *Tetratheca* (*T. harperi*, *T. paynterae* subsp. *cremnobata* and *T. paynterae* subsp *paynterae*) which are almost exclusively restricted to growing from fissures less than 1cm wide. Translocation will have to rely on planting seeds into fissures within the massive banded ironstone. Currently there is no way of knowing which fissures will be suitable for germination and seedling establishment.
- Although the environmental domains of *T. harperi*, *T. paynterae* subsp. *cremnobata* and *T. paynterae* subsp *paynterae* differ in some aspects they are similar enough to be considered ecological analogues. The relatively undisturbed, *T. harperi*, and *T. paynterae* subsp. *cremnobata* will provide useful bench-marks for gauging the performance and viability of the *T. paynterae* subsp. *paynterae* population in the mine and post-mine environments.

- Climate variables particularly the amount and season of rainfall are key drivers of population dynamics and plant growth in the four BIF *Tetratheca* taxa.
- PVA indicates that further reducing the size of the *T. paynterae* subsp. *paynterae* population will reduce the viability of the population and that population viability may be very sensitive to an increase in the mortality of reproductive adult plants. This is typical of stress tolerators which are able to persist under adverse conditions.

Future directions (next 12-18 months)
Submit two scientific papers to refereed journals describing the research.

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 (DFR) 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 two named subspecies.
    - *Calytrix breviseta*; status of hills population and taxonomic status of two 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
- A paper naming two highly restricted *Stylidium* species (with J Wedge and B Keighery) has been published.

- Paper describing new highly restricted *Lomandra* from the Whicher Range published.
- Paper describing New *Hypoxis* from Wheatbelt (with M Lyons) published.
- Paper describing new highly restricted *Loxocarya* subspecies from the Whicher Range published.
- Oxalis corniculata note in Western Australian Wildflower Society Newsletter.
- A paper describing the six DRF *Darwinia* species with phrase names is in press.
- A paper formally naming the rare subspecies of *Apium prostratum* 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* completed and in press.
- Taxonomic notes on *Cynoglossum* completed and in press
- New rare subspecies of Grevillea brachystylis formally described.

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# 2004/022

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 on WorldWideWattle website 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 two new subspecies being recognized, and taxonomic problems in many other taxa resolved. Taxonomic paper prepared and submitted to Nuytsia for publication.
- Descriptions, distribution maps and photographs assembled for all Pilbara taxa summarizing relevant information on morphology, biology, ecology, distribution, utilization and conservation status. These data to be presented in 'Guide to Wattles of the Pilbara' which is near completion
- Electronic key to identification of Pilbara Wattles completed. This key to accompany 'Guide to Wattles of the Pilbara' and also to be published on WorldWideWattle website.
- Bush Book manuscript in which 32 Pilbara taxa are described and illustrated has been submitted for publication.

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 (in Nuytsia) and Bush Book: both currently in press.
- Complete and publish 'Guide to Wattles of the Pilbara'.

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), J. Reid (0.1); Total (0.4).

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* published (with P Wilson).
- Description of three new Kimberley species completed (with M Lewington)
- Miscellaneous new Western Australian Wattles described, including *Acacia burrowsiana* and *A. cockertoniana*.
- 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# 2000/013

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 maintain an *Acacia* website (WorldWideWattle) which is co-hosted by the Shire of Dalwallinu.
- To participating in the creation of an Environmental Interpretive Centre in Dalwallinu.

Summary of progress and main findings

- *Acacia* Symposium undertaken (2001).
- WorldWideWattle website developed and is being maintained. During 2007-08 a new webmaster was engaged to the project.
- Attended in meetings in connection with the Environmental Interpretive Centre in Dalwallinu.

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), J Reid (0.9), J. Sampson (0.1); External collaborators (J Miller, Uni. Iowa; R Rutishauser, Uni Zurich); Total (1.6).

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, Ashburton and Pilbara districts to collect material for taxonomic and genetic study, and seed for ontogenetic study (2006 and 2007).
- Microsatellite library constructed.

- DNA extracted for 2006 and 2007 collections and sent to Miller for analysis.
- Preliminary cDNA and microsatellite results analysed.
- Preliminary taxonomic sort of the herbarium collections undertaken.
- Web presentation of the Understanding Mulga project posted on WorldWideWattle website.
- Seed 2006 field study germinated and seedling growth characters scored.

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.
- Collect relevant material from Acacia aneura type locality in Flinders Range, South Australia.
- Continue genetic sequencing based on DNA extracted.
- Continue scrutiny of collections and to relate taxa thus recognized to groups defined by the genetic and other studies.
- Progress ontogenetic and anatomical study.
- Transplant seedlings in W.A. Herbarium glasshouse to Mulga plots at Curtin University.

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# 1993/011

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
- To publish a series of taxonomic papers, including many new genera and species.
- To continue to update the list of taxa requiring conservation priority.
- To complete 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 now includes over 700 taxa.
- From 2005 to 2008, 13 papers have been published and 1 is currently in press. Five additional papers on the Myrtaceae have been submitted and a paper on *Petrophile* is close to submission.
- 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.
- Conduct field studies on poorly collected and taxonomically difficult species groups.
- Prepare a paper on *Isopogon*.

DEC Regions

All.

IBRA Regions

All.

Resolution and description of new plant species in the Yilgarn ironstone and Ravensthorpe Range areas subject to mining interest

SPP# 2007/009

Team Members.

R Butcher (1.0), K Shepherd (1.0), T Macfarlane (0.1), J Wege (1.0), C Wilkins (0.25).

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 1,600 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 two focus regions: the Banded Ironstone Formations of the Yilgarn and the Ravensthorpe Range and Bandalup Hill. This project also targeted unnamed Priority and Declared Rare Flora from other regions of Western Australia, including the Swan Coastal Plain.

Outcomes

- Publication of a 492-page special edition of *Nuytsia* (Volume 17) which includes:

    - 45 papers, of which 22 were completed by team members and 13 by other DEC staff members.
    - Over 70 Australian and international botanists contributed to the special edition, either through completing manuscripts or through peer-reviewing papers.
- formal descriptions and up-to-date conservation assessments for 95 new plant taxa of which 36 are from the BIF ranges or other ironstone habitats, six are from the Ravensthorpe area and 78 are listed on Western Australia's *Declared Rare and Priority Flora List for Western Australia*.
- updated information for a further 28 named taxa, and identification keys for several genera.
- Completion of a further five taxonomic manuscripts (*Dysphania, Platytheca*, *Stylidium*, *Tecticornia*, *Tetratheca*) for publication in *Nuytsia* Vol. 18(1).
- 113 new additions to the *Declared Rare and Priority Flora List for Western Australia*.
- Improved knowledge of several species complexes within *Eutaxia*, *Gastrolobium*, *Hakea*, *Platytheca*, *Pultenaea*, *Sclerolaena, Stylidium*, *Synaphea* and *Tecticornia*, including the completion of draft descriptions for 25 new taxa and revised descriptions for 16 taxa.
- 8 phrase-named taxa were added to Western Australia's plant census as a result of taxonomic assessment.
- Team members have provided expert determinations for *c*. 2350 specimens at the Western Australian Herbarium.
- Field studies have resulted in the acquisition of 256 herbarium specimens for the State collection.

Management Implications

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

Future Directions (next 12 months)

- Assess and formalize the taxonomy of new Western Australian plant taxa, particularly those of conservation significance.
- Conduct field studies on poorly collected and taxonomically difficult species groups.

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 the draft State biodiversity conservation strategy and Science Division Strategic Plan goals to describe new taxa, necessary for an adequate understanding of plant biodiversity in Western Australia.

Aims

- To revise generic concepts in line with recent systematic studies.
- To publish in *Nuytsia* of new taxa in these genera.
- To detail a description of a number of species in each genus.
- To publish 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.
- Collaborative paper revising the generic limits of *Oligarrhena* and WA *Monotoca* commenced.
- Joint paper publishing three new species of *Leucopogon* published in the journal *Nuytsia* 17(2007).
- 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 20 taxa.
- Publication of paper describing *Monotoca aristata* ms and its systematic placement.
- Publish further detailed WA *Leucopogon* 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

SCP# 2007/013

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.
- To publish results as journal articles and as contributions to FloraBase.

Summary of progress and main findings

- *Wurmbea* (Colchicaceae): field work in Goldfields studying a presumed new species, with partial resolution of the taxon. Paper published on a new species from the Gascoyne region. Paper published on phylogeny in relation to flower evolution with overseas colleagues.
- Hydatellaceae came to prominence as a primitive Flowering Plant in overseas work. Published four papers with Australian and overseas colleagues. Field work and sample collection for various studies in south west WA and Northern Territory, including re-location of a DRF species.
- *Austrodanthonia* (Poaceae): further fieldwork on an undescribed species in the wheatbelt, sufficient to proceed with its formal description.
- *Neurachne* (Poaceae): published a paper describing a new species from the Yilgarn.
- *Pentapogon quadrifidus*: published a paper substantiating the native status and clarifying the conservation status of this species which has only recently been discovered in WA.
- *Petrophile* (Proteaceae): published a paper describing a new species from ironstone in the Yalgoo region.
- Interactive key and descriptive database for WA genera and families of Flowering Plants for FloraBase content: keys to the Families and to the genera of various families integrated into FloraBase.
- *Thysanotus*: supervision of a research student studying the phylogeny of the genus. Conducted fieldwork to obtain research material, including discovery of a new species, with draft paper prepared to describe it. Progress made with research aimed at a taxonomic revision of the genus.
- Collected DNA material of various genera, especially grasses, for a major collaborative study of south western plants being conducted at Kew Gardens.
- *Baeckea* group (Myrtaceae): continued in supervisory and coordination role for this collaborative project of BL Rye and ME Trudgen who are revising the taxonomy of this large group of small-flowered myrtle shrubs. Contributed to preparation of an interactive key led by BL Rye.

- 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 developing a standard national list of accepted plant species for Australia. Several new parts prepared in Canberra were processed during the year.
- Participated in the Warren Region Flora Recovery Team annual meeting and contributed expertise to Regional staff on flora conservation matters, especially for staff of Warren, South West and Swan Regions.
- Weeds: participated in Manjimup Weed Action Group. Participated as a presenter at a Blackberry identification training workshop at Jarrahdale for the National Blackberry Taskforce.
- Quarram grasslands management team, Frankland District – provided botanical support, especially for post-fire monitoring and preparation of a Threatened Ecological Community nomination.
- Taxonomic review of *Leptospermum spinescens* (Myrtaceae) as an investigation into a proposed new species in the Ravensthorpe Range. Draft paper further progressed (R Cranfield).
- Paper submitted describing *Atriplex* sp. De Grey (Chenopodiaceae) as a new species (R Cranfield).
- A draft revision of *Brachyloma* (Epacridaceae) which has been carried out over several years was further progressed.

Future directions (next 12-18 months)

- Submit papers describing various new species.
- Progress with ongoing taxonomic studies of various plant groups (e.g. *Wurmbea*, *Thysanotus*, Hydatellaceae, Poaceae) to improve knowledge of the flora.
- Contribute further interactive keys to genera for FloraBase.

DEC Regions
All.

IBRA Regions
All.

NRM Regions
All.

Taxonomic studies in selected familes, including Asteraceae, Celastraceae Malvaceae, Proteaceae
SCP# 2008/001

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

- To revise genus *Olearia* in Australia.
- To resolve BCI species in Asteraceae, Celastraceae, Malvaceae.
- To publish in Nuytsia and other suitable journals of new taxa in the above groups.
- To publish review of genus *Erodiophyllum*.
- To publish 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 accepted, revised, in press: Elucidation of *Olearia* species related to *O. paucidentata* (Asteraceae: Astereae).
- Paper accepted, revised, in press: New species of *Olearia* (Astereaceae: Astereae) from Western Australia.
- Paper completed: Review of the genus *Erodiophyllum* (Asteraceae: Astereae).
- Paper completed: Pilbara, a new genus of Asteraceae (Astereae) from Western Australia.
- Interactive key to WA *Grevillea* Species. Ported to Lucid and submitted. Descriptions prepared and submitted for publication in FloraBase.
- Interactive key to WA Asteraceae Genera. Major revision of data base undertaken, ca two-thirds complete (109 of 188 genera).

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 Biodiversity Conservation Initiative 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 (0.2), 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 Coffey (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
- 23 300 specimens were added to the collection, which now stands at 683 339, a 3.4% increase during the year.
- The major plant groups in the collection are as follows:

Taxonomic Group	**Number of specimens (June 2008)**	**Increase since June 2007**	
		Number	%
Myxomycetes	590	23	18.8
Fungi	19914	-2203*	-10*
Lichens	15177	705	5
Algae	22188	959	4.5
Liverwort & Hornworts	1876	47	2.5
Mosses	6408	85	1.3
Ferns and fern allies	3428	71	3.1
Gymnosperms	1945	39	2
Flowering Plants	611813	12 226	2
Total number	683339	23300	3.4

*reduced as a result of completion of incorporation of fungi specimens from the CSIRO collection; 2007 figure included an estimate of numbers in that collection

Curation
- Significant curatorial work was accomplished in the genera *Eucalyptus*, *Leucopogon*,

Lepidosperma, *Eremophila*, *Acacia*, , *Banksia, Dicrastylis*, *Tecticornia*, and groups including the small flowered Myrtaceae, moss and liverworts.

- Declared Rare Flora taxa curated, see under WACensus and WAHerb.
- Significant collections added to the Herbarium holdings were as follows:
    - Yilgarn Ranges Survey.
    - Ravensthorpe Range Survey
    - Eucalypts from Malcolm French
    - Woodland Watch.
    - Pilbara Regional Herbarium.
    - Threatened Flora Seed Centre vouchers.
    - Kings Park.
    - DEC Regional Offices and Regional Herbaria.
    - Range of Environmental Consultancies
- Loans and exchange
    - Loans outward – 2923 specimens.
    - Loans inward - 497 specimens (including images on CD)
    - Exchange outward – 3431 specimens.
    - Exchange inward - 1146 specimens
- Managed and supported by the curatorial staff, volunteer participation again was significant, totaling 11 000 hours (equivalent to 6.0 full-time positions).
- Tasks Managed by curation staff with the assistance of volunteers were as follows:
    - Mounting 18 000 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:
    - Validating C.A. Gardner collections
    - Curating *Austrostipa*, *Eucalyptus*, *Pterostylis*, *Verticordia* and *Calandrinia.*
    - Capturing and preparing composite images for FloraBase (see below).
    - Increasing the collection and documentation of Myxomycetes
    - Completing keys to Proteaceae genera including *Hakea, Grevillea, Conospermum*, *Banksia, Isopogon and Petrophile*, and continuing with keys to other genera of including the difficult genus *Synaphea*.

Reference Herbarium

- Maintained and increased the number of taxa represented in the Reference Herbarium. The Reference Herbarium currently has 14162 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.

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.

This activity aligns with Corporate Priorities KRA 1; KRA 2; KRA 3; KRA 4; KRA 5; KRA 6 and Science Division Strategic Goals G1, G2, G3, G4 and G6.

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 625 new names were added to WACensus, with 87 being new manuscript or phrase names and 538 being published names.
- A total of 670 edits were made to WACensus.
- WACensus updates are regularly distributed to over 436 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 Western Australian 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.

This activity aligns with Corporate Priorities KRA 1; KRA 2; KRA 3; KRA 4; KRA 5; KRA 6 and Science Division Strategic Goals G1, G2, G3, G4 and G6,

Aim

To capture, maintain and validate spatial, phenological, population and 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

- 23 304 records were added during 2007-08.
- Records for 1 065 Priority Flora and 159 Declared Rare Flora were added to the database.
- 141 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.

FloraBase – the Western Australian flora

Core Function

Team Members

A Chapman (0.4), B Richardson (0.4), 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 three 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 – 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.
- Development of infrastructure and methods for adding interactive keys - stage two completed.
- Addition of infrastructure to support the presentation of cryptogamic elements of the flora - stage two completed.

Botanical content

- Addition of further interactive keys for the WA genera and families, part-funded by the Save Our Species (SOS) project. – stage two ongoing.
- Integration of available PDF's of *Nuytsia* journal protologues more tightly into FloraBase, part-funded by the SOS project – ongoing.
- Addition of upgraded map display (Extension to FloraBase Spatial Query) – ongoing.
- Addition of full access to all Census data fields for query and display in FloraBase – ongoing.
- Maintenance of generic and family descriptions – ongoing.
- Maintenance of standard descriptive data for new and revised species – over 800 coded species descriptions added over the year – ongoing.
- Maintenance of flora statistics page, publishing summary data on numbers of WA flora – completed for 2008.
- 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)

- Commence the development of the next major version of FloraBase.
- Upgrade the management of coded species descriptions in light of the findings of the 2006 DESCAT Review.
- Add new content, including interactive keys for identification of several plant groups at species level.
- Add further standards support to allow FloraBase to participate in national and international bio-infrastructure projects.
- Add further necessary infrastructure to support the presentation of cryptogamic elements of the flora and collaborate with scientists on the addition of content for the algae, lichens and fungi of WA.
- Maintain the quality of information and the adequacy of software and hardware systems.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Biodiversity Informatics at the Western Australian Herbarium

Core Function

Team Members

A Chapman (0.1), B Richardson (0.2).

Context

DEC's Science Division databases contain a large amount of quality biodiversity data. For some of these databases, there is no means of access other than direct to the database itself. DEC can better promote the understanding of Western Australia's natural biodiversity by providing access to this data through web services. The most important method of providing access to biodiversity information is through the use of data standards created by international biodiversity information standards bodies. These standards describe the way in which biodiversity data should be represented and requested by software other than web browsers, and makes it possible to recombine the data in powerful new ways.

Aim

To deliver DEC's biodiversity data to the Internet using standards-compliant web services and data structures.

Summary of progress

- Implementation of a web service interface to support provision of DEC biodiversity data to Australia's Virtual Herbarium and the Global Biodiversity Information Facility —in progress.
- Implementation of Digital Object Identifiers across DEC bibliographic databases—in progress.
- Implementation of the burgeoning Life Science Identifier standard for tagging individual specimens, names, images and other biodiversity data uniquely—planning commenced.

Future directions (next 12-18 months)

- Organize and host the international Biodiversity Information Standards (TDWG) Annual Conference in October 2008.
- Finalize the implementation and launch of the new Australia's Virtual Herbarium web service.
- Collaborate with national and international bodies in the definition of standards for biodiversity information.
- Collaborate in projects that simplify the use of biodiversity information in the online context, e.g. co-authorship of software that our clients can download and use.

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 and Trade) over previous years. Completion of the 'Flora of North-western Australia has been delayed slightly due to Huisman's other projects (including several expeditions to the region), but there has been substantial progress. Portions of the manuscript have been forwarded to ABRS for editing and the project should be completed in late 2008, at which time a full 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 published (Cryptogamie, Algologie) describing the phylogenetic relationships of the poorly known green alga *Boodlea vanbosseae*.
- Paper published (Western Australian Museum) providing an annotated list of the marine plants of Mermaid Reef in the Rowley Shoals, Scott Reef and Seringapatam Reef . This was a preliminary report and the updated version has been submitted to the Records of the Western Australian Museum.
- Article in Landscope (Winter 2007) describing the results of an expedition to the north-west atolls.
- A further Lanndscope article (Spring 2008) describing the December 2007 expedition to the Rowley Shoals.
- Studies of Western Australia's temperate marine flora are also ongoing and have resulted in the recognition of an introduced species (*Pseudocodium devriesii*) and a paper revising the genus. A paper describing the latitudinal patterns of algal distributions has been accepted for publication in the Journal of the Royal Society of WA. Also, a paper describing the marine biota introduced to WA has been published in the Records of the WA Museum.

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'. 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 2007/2008, $41 000 for 2008/2009 with indicative funding for 2009/2010).

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

- The majority of generic descriptions and photographs to be used in the key have been collated and sections of the character scoring has been complete.
- Several hundred species descriptions have been collated or newly generated. These are awaiting final editing before uploading to FloraBase.

Future directions (next 12-18 months)

- Complete generic descriptions and coding of LUCID key.
- Continue collating 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 (PUBF) Project

Core function

Team member

N Bougher (0.4), R Hart (0.3), S DeBueger (0.2), B Glossop (0.1); Total (1.0).

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 100 workshops and forays in 48 urban bushlands.
- Produced foundation fungi inventories for 30 bushlands.
- Recorded 3637 fungi.
- Processed and vouchered about 800 fungi specimens for WA Herbarium collection.
- Published fungi reports for seven community group bushlands and three regional parks, and made these available online.
- Completed data management process to integrate CSIRO fungal collection comprising ca 11 000 specimens into the WA Herbarium.
- Re-designed, updated and launched the PUBF website at www.fungiperth.org.au.

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 five public field events (forays and workshops) and three contracted surveys during the 2008 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.
- Produce expanded edition of the Perth fungi field book.
- 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 project 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.

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

- Published accounts of fungi genera Agaricus, Campanella, and Tubaria.
- Investigated and reported with DEC recovery team about fungi in the diet of translocated Gilbert's Potoroos.
- Investigated and reported with postgraduate student and DEC research team about fungi associated with Woylie conservation.
- Promoted access and uptake of fungi scientific knowledge, and completed 11 biological surveys, via the Perth Urban Bushland Fungi Project.

- Conservation status of two species of the genus Torrendia designated as Priority Flora.

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.

Taxonomic studies in Epacridaceae, Rafflesiaceae, Rhamnaceae and Violaceae

SPP# 2007/015

Team members

K Thiele (0.1).

Context

This project involves systematic research, particularly resolution of species boundaries and descriptions of new species, in a number of families of Western Australian plants. Describing new species, particularly conservation taxa, is of fundamental importance for conservation, as it provides an underpinning to all other biodiversity research.

The families studied in this project include taxa of high conservation and biodiversity significance.

This activity aligns with Corporate Priorities KRA 1; KRA 2; KRA 3; KRA 4; KRA 6 and Science Division Strategic Goals G1 and G2.

Aims

- To collect and curate specimens for the WA Herbarium collection in the target families.
- To assess species boundaries and describe new species.
- To document the conservation, taxonomic and nomenclatural status of species.

Summary of progress and main findings

- A new species of *Pilostyles* (Apodanthaceae formally Rafflesiaceae) from the Northern

Sandplains has been recognized and described (paper in press in *Nuytsia*). *Pilostyles* is an unusual genus of parasitic flowering plant which grows internally within the stems of host legumes. Resolution of the new species means that all three Western Australian species of *Pilostyles* are restricted to a single host genus, raising interesting issues regarding host specificity and adaptations.

- The *Lysinema ciliatum* species complex (Epacridaceae) has been revised. Previously, eleven phrase-named taxa have been included on the Western Australian Census in this species complex. Assessment of variation based on herbarium specimens and field observations has indicated that one of these, *L. ciliatum* forma Mt. Barren, is a distinct species, but the others represent a single variable taxon. Formal description of the Mt. Barren form awaits examination of Type material from European herbaria.

Future directions (next 12-18 months)

- A paper describing *Lysinema ciliatum* forma Mt. Barren will be prepared and submitted
- Work on the taxonomy of undescribed species in *Hibbertia* (Dilleniaceae) will proceed and is expected to lead to new species including Priority species from the Ravensthorpe Range

Management implications

Knowledge of, and the ability to recognize plant species in Western Australia is critical for conservation planning and management.

DEC Regions

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

IBRA Regions

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

NRM Regions

Northern Agricultural, Swan, South West, South Coast.

Development of interactive identification platforms and content

SCP# 2007/014

Team members

K Thiele (0.1); C Hollister (0.4).

Context

Botanical identification keys are important tools that allow a wide variety of people – researchers, DEC staff, consultants, students and members of the general public – to identify plants. Good keys are particularly important in Western Australia in the absence of a complete Flora for the State.

This project is developing, in conjunction with botanists and other members of the Herbarium community, a range of computer-based, interactive identification keys for various groups of Western Australian plants, using the Lucid software tools. Completed keys will be published on FloraBase for community-wide access.

Aims

To develop user-friendly and accurate identification keys for important groups of Western Australian plants.

Summary of progress and main findings

- Three keys have been developed and submitted to FloraBase for publication during 2007-2008:

    - The Grevilleas of Western Australia;
    - The Hakeas of Western Australia; and
    - Key to the family Casuarinaceae in Western Australia.
- Significant progress has been made towards preparation of five other keys
    - Isopogons and Petrophiles of Western Australia;
    - Banksias of Western Australia;
    - Comospermums of Western Australia;
    - Persoonias of Western Australia; amd
    - Key to *Hibbertia* in Western Australia.

Future directions (next 12-18 months)

- Complete and publish the five keys listed above.
- Progress keys to *Boronia*; Grass genera, Myrtaceae tribe Chamelaucieae, Pittosporaceae.

Management implications

The ability to accurately identify plant species in Western Australia is critical for conservation planning and management.

DEC Regions

All.

IBRA Regions

All.

NRM Regions

All.

Surveys, systematics and genetic diversity of granitic vernal pools flora

SPP not allocated

Team members

M Moody (0.5); Total (0.5).

Context

The granite outcrop vernal pools (gnammas) are one of the highly unique ecosystem to Western Australia and perhaps one of the most threatened by global climate change. Yet, these systems have received little attention and their biodiversity and ecology is poorly known. Several of the more conspicuous plants of the vernal pools have been recognized as priority or rare, with less conspicuous plants poorly known. A comprehensive plant survey and genetic study of these systems will provide an understanding of their diversity, composition likely discover cryptic species. Population level genetic studies of rare species in the system will provide information on genetic diversity in populations and gene flow among populations to assess the immediate threat these species may face due to loss of habitat.

This research specifically addresses the DEC strategic plan goals G 1.13, 1.16, 1,23,1.25, 1.26 and 1.27.

The project aligns with Corporate Priorities 5 and 12, KRA 1; KRA 2; KRA 3; KRA 4; KRA 6.

Aim

- To determine the plant diversity in the granitic vernal pools of southern Western Australia. Apply molecular tools to identify cryptic species or subspecies (unique lineages) among the often inconspicuous and difficult to identify aquatic plants. Develop a DNA barcode for the rare and

priority species of the gnammas.

- To use genetic tools (microsatellites and/or AFLPs) to examine the genetic diversity of rare and/or priority plants in this system (e.g., *Trithuria occidentalis*, *Myriophyllum lapidicola*, *M. balladoniense*) and compare with more common plants (e.g. *Glossostigma drummondii*, *Isoetes australis*).
- To monitor, survey ecological factors that are important to these systems (e.g., water depth, sediment nutrient content, etc.).

Summary of progress and research findings

- Grant proposal writing and background literature review is in preparation for an ARC linkage grant.
- Conducted observations and plant collections at granites of Cape Arid and Cape Le Grand National Parks and the central wheat belt.
- Performed preliminary genetic analyses on *M. petraeum* (Priority 4) from wheat belt and Cape Arid region, finding species level divergence between the taxa from these regions, uncovering likely cryptic species.
- Identified transferability of microsatellite markers to *Myriophyllum balladoniense* (Priority 4) from those developed for *Myriophyllum spicatum*. These marker may be useful for population level studies among rare or priority species of this genus in WA vernal pools.
- Identified collaborative bodies for ARC linkage corporate sponsor.

Management implications

To identity of species level divergence in the southwest will likely lead to the description of a new rare species for the southern range of the granitic pools of Western Australia.

Future directions (next 12-18 months)

- Proceed to submittal phase of ARC linkage grant.
- Test microsatellite markers developed for other *Myriophyllum* spp. For transferability to those rare and priority in the vernal pools, particularly the DRF *M. lapidicola*.
- Perform preliminary surveys of gnammas in August-September for data that can be added to the ARC –l linkage.
- Collect molecular data from collections made at gnammas for preliminary analyses of genetic diversity.

DEC Regions

South Coast, South West, Warren, Wheatbelt.

IBRA Regions

Avon Wheatbelt, Coolgardie, Esperance Plains, Jarrah Forest, Mallee.

NRM Regions

Avon, South Coast, South West.

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), G Phelan (0.2), J Fielder (0.2), V Tunsell (0.2), B Ward (0.2), A Wills (0.2), P Van Heurck (0.1); Total (2.5).

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 and management effectiveness 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 five locations (Blackwood Plateau, Donnelly, Perth Hills, Wellington, Wellington East) throughout the jarrah forest.
- Sampling of soil compaction, cryptogams (lichens, liverworts and mosses), macrofungi, vascular plants, invertebrates, terrestrial vertebrates and birds has been completed for all grids. Stand structure (basal area and stocking of overstorey species) have also been measured.
- 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.
- FORESTCHECK has been accepted into the network of Australian Long Term Ecological Research sites.
- A poster paper describing the objectives and sampling strategy of FORESTCHECK was presented at the Old Forests New Management conference in Hobart in January 2008.
- Ten sites in Donnelly district were re-measured during 2007/2008, and supplementary data on the size and condition of coarse woody debris at each site were gathered.

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 five years of monitoring is currently in progress.
- Publish a series of papers on the results of the project, with manuscripts submitted in the last

quarter of 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# 1993/099

Team members
N Burrows (0.05), B Ward (0.20), R Cranfield (0.05), G Liddelow (0.1); Total (0.40).

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.
- Soil samples were collected from each of the fire treatments and analysed for physical and chemical properties.
- A draft paper comparing tree diameter growth rates over 20 years at the Perup forest site and under different fire treatments has been prepared for publication. Fire treatments, including frequent burning and fire exclusion, had no significant effect on tree diameter growth, or tree mortality, which were mostly influenced by tree dominance status and size. Preliminary analyses of soil samples shows variation across the treatments but no consistent effect of fire.

Management implications
Based on 20 years of monitoring, there is no indication that regular prescribed burning at 6-10 year intervals, or long periods of fire exclusion, is having any significant effect on tree mortality and growth rate in low rainfall (~700 mm annum^{-1}) jarrah forest.

Future directions (next 12-18 months)
- Maintain fire treatments at both study sites.
- Publish tree growth findings.
- Re-measure floristics on all plots (except Lindsay forest) in spring 2008.
- Preliminary analysis of data in summer 2008/2009 and review future of study.

DEC Regions
South West, Warren.

IBRA Region
Jarrah Forest.

NRM Region
South West.

Project Rangelands Restoration: Developing sustainable management systems for the conservation of biodiversity at the landscape scale in rangelands of the Murchison and Gascoyne bioregions
SPP# 2003/004

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

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 DEC's Goldfields Region, this project aims to reconstruct some assemblages of the original native mammal fauna on Lorna Glen, a pastoral lease recently acquired by DEC. This will be achieved by an integrated approach to controlling introduced predators and herbivores, ecologically appropriate fire management and fauna translocations.

This project aligns with 2005/2006 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 translocation once 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, 2005 and 2006, a follow-up operation

was carried out in winter 2007, as part of the Western Shield program. Baiting successfully reduced the feral cat density by about 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.

- Translocation plans were prepared for two native mammal species that previously occurred in the area; bilby (*Macrotis lagotis*) and brushtail possum (*Trichosurus vulpecula*). Following successful baiting, bilby and brushtail possum were reintroduced to Lorna Glen and monitored by radio telemetry and trapping. The bilbies came from DEC captive breeding programs at Shark Bay and Dryandra, and the possums were wild caught from the south west Wheatbelt region. There was an initial spate of mortality amongst the bilbies due to a combination of predation and dislocation (inability to utilize/adapt to new habitat), but the founder population stabilized within six months. Brushtail possums are coping well at this stage, with a very low level or mortality.
- Fire ecology (plants) and vertebrate monitoring sites were re-assessed. Thirty new vegetation condition assessment quadrats were established.
- Strategic buffer and research burning was successfully carried out according to the fire management plan.
- Installation of new boundary fencing is almost near completion.

Management implications

- Guidelines for the proactive management of fire in the arid zone rangelands 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 rangelands.
- Reconstruction and protection of arid zone rangelands mammals, other extant fauna, vegetation and other elements of the biota.
- A framework and protocol for assessing and reporting trends in ecosystem condition in arid zone rangelands.

Future directions (next 12-18 months)

- Implement and assess the effectiveness of a fifth annual feral cat baiting program in July 2008.
- Increase the population of bilbies and brushtail possums by further reintroductions.
- Reintroduce another two native mammal species.
- Continue to monitor extant fauna and vegetation.
- Continue assessments of fire plant ecology sites.
- Revise the Fire Management Plan.
- Complete analysis and write-up of first stage of fire ecology (plants) study.
- Write-up and publish results of baiting trials at Lorna Glen.
- 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.
- Collate a progress report and promote and publicize of all facets of the Rangelands Restoration project.
- Seek partnerships with corporate sector.

DEC Region
Goldfields.

IBRA Regions
Murchison, Gascoyne.

NRM Region
Rangelands.

Walpole fine grain mosaic burning trial

SPP# 2004/004

Team members
N Burrows (0.05), 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 determine whether a fine-scale mosaic of vegetation at different seral (post-fire) stages benefits biodiversity at the landscape scale. Specifically:
    - The 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*) under this fire regime.
    - 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.
- To develop the operational techniques to be able to use frequent and planned introduction of fire into the landscape (patch-burning) to create a fine-scale mosaic of patches of vegetation at different stages of post-fire development.

Summary of progress and main findings
According to plan, no burning was conducted over this 12 month period. Biodiversity monitoring grids were assessed.

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 2008.
- Establish and assess further grids in long unburnt vegetation.
- 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# 1998/007

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 population relationships of *Acacia saligna*; 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* – Mating system paper has been published in *Silvae Genetica*. Genetic diversity in additional populations of the complex are being investigated to further clarify the taxonomic relationships of these unresolved populations.
- *S. album* – Genetic diversity paper has been submitted to *Tree Genetics and Genomes*.
- *S. spicatum* – Microsatellite markers have been developed and are being tested for polymorphism. Journal paper on mating system of *S. spicatum* has been published in *Silvae Genetica*.
- *E. occidentalis* – Trees in a salinity/waterlogging trial have been genotyped to determine genetic relationships, and are currently being analysed 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 two 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)

- Analysis of additional populations of *A. saligna* will be completed and taxonomic identification clarified.
- Journal papers will be written for *A. microbotrya*, *E. cladocalyx*, and *E. marginata*.
- Genetic relationships between *E. occidentalis* trees will be 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* – Genotyping of 20 individuals from 20 populations has been completed and data analyses are currently being undertaken.
- *Kennedia coccinea* – Microsatellite markers have been developed and tested for polymorphism.
- Guidelines for seed collections for revegetation have been written and submitted for publication.

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 structure will be determined for *B. ornata*.
- 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 Future Farm Industries CRC.
To determine the mechanisms, extent, implications and management of genetic risk for selected taxa in commercial development.

Summary of progress and main findings
- 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.
- Journal paper on the environmental weed risk management strategy in the CRC published in Australian Journal of Experimental Agriculture.
- Development and ratification of an environmental weed risk policy in the CRC PBMDS.
- Journal paper on an environmental weed risk management strategy for pasture research programs accepted for publication in Plant Protection Quarterly.
- Continued involvement in national discussions on improvements to border and post-border weed risk assessment, including teleconferences and two workshops.
- Data collection completed for research study 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.
- Continue small research study on the impact of the exotic species *Plantago lanceolata* on regeneration of native flora following a fire.
- Journal paper on extensive pollen dispersal between planted *E. loxophleba* ssp *lissophloia* and natural *E. loxophleba* ssp. *supralaevis* has been published in Molecular Ecology.
- Genetic analysis shows significant differentiation between Western Australian and eastern Australian populations of *Atriplex nummularia* consistent with their identification as separate

subspecies. Genotype data confirms the species is polypoloid.

- Journal paper on microsatellites in *Atriplex* accepted for publication in Molecular Ecology Resources.

Management implications

- Introduction of weed risk management and culture into the FFI 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)

- Update Salinity CRC weed risk management policy for FFI CRC.
- Develop best practice management guidelines for key species with some weed potential but significant agricultural benefit for publication by the FFI CRC.
- Continue technical advice to FFI CRC researchers on weed issues.
- Publish 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, including the revision of the National Protocol for Post-Border Weed Risk Management.
- 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, through consultation with agencies and stakeholders across Australia.
- Write journal paper on genetic structure in *Atriplex nummularia.*
- The taxonomic identity of weedy populations of *Acacia saligna* will be determined using genetic markers to evaluate whether there are different subspecies and whether they are spreading clonally or by seed.

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

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.

State Salinity Strategy wetland monitoring

SPP# 1998/018

Team members

Fauna - A Pinder (0.1), D Cale (0.5), M Pennifold (0.3); R. Gordon (0.1); Flora - M Lyons (0.2), C. McCormick (0.75); Surface water - J Lane (0.35), A Clarke (0.5), Y Winchcombe (0.4), B Muir (0.05); Groundwater - M Lyons (0.05), contracts; Total (3.3).

Context

Substantial loss of biodiversity has occurred across the Wheatbelt of Western Australia over the past 100 years. The most pronounced physical changes at wetlands have been associated with native vegetation clearing and salinization. Broadscale clearing has more or less ceased but salinization and fragmentation process will continue to be expressed for 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.

- Case study paper reporting whole of project results for Paperbark Swamp and Eganu Lake published in Hydrobiologia.
- *Fauna monitoring* – field component of 2007 monitoring completed, invertebrate dataset being reviewed in preparation for a report on data between 1997 and 2006. Report completed for

biodiversity survey of Lake Bryde Recovery Catchment wetlands. Poster presented at 2008 WA Wetlands Management Conference.

- *Surface water monitoring* – 2007 depth and water quality monitoring undertaken. 2007 data added to SWWMP database. Data supplied to varied users. Survey of all depth gauge benchmarks to Australian Height Datum completed. Delineation of catchment / subcatchment boundaries of SWWMP wetlands commenced. High resolution oblique aerial photography of 36 SWWMP wetlands obtained. Review of sub-program scope, outputs and linkages undertaken.
- *Wetland bathymetry* – Bathymetric maps and depth-volume calculators for Lakes Brown and Campion completed.
- *Vegetation monitoring* for 2007 completed. Database of 1997-2007 vegetation data completed and edited.
- *Ground water monitoring* - for 2007/2008 completed and data compiled. Routine logger and bore maintenance completed for 2007/2008.
- *Management* – contributed to Bryde, and Drummond, TAG's, provided advice to Wheatbelt region in assessing impacts of proposed drainage into Lake Parkeyerring and Lake Coomelberrup. Developed a scheme for assessing the suitability of wetlands to receive drainage for Wetlands Co-ordinating Committee (endorsed by Cabinet Sub-Committee for the Environment) and supplied data and advice to the "W.A. Trial of national indicators for wetland extent, distribution and condition" and to other users.

Management implications

- Analyses of trends in depths, salinities and pH of wetlands monitored for 20 or more years have revealed a number of wetlands undergoing diverse changes that warrant further investigation and corrective management.
- Loss of vegetation is continuing even at long-salinized 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.
- Following rare flooding events in the Lake Bryde Recovery Catchment wetland salinity is greatly reduced and invertebrate communities are of much greater diversity. This shows that wetlands that are slightly to moderately degraded have the capacity to support highly diverse communities when limiting environmental conditions (e.g. cyclical low water level and high salinity) are removed. Wetlands need to be managed to maintain their resilience by minimizing further degradation and maintaining the catchment.

Future directions (next 12-18 months)

- Continue monitoring according to current protocols.
- Report on trends in depth and water quality of wetlands monitored 20+ years to 2007 during 2008/2009 financial year.
- Report on trends in waterbird and invertebrate biodiversity for whole dataset between 1997 and 2006 during 2008/2009 financial year.
- Report on trends in vegetation for whole dataset between 1997 and 2007 during 2008/2009 financial year.
- Complete scientific paper for Lake Bryde Recovery Catchment survey to document invertebrate communities, post flood event, at lake and catchment scales.
- Begin producing pamphlets on aquatic invertebrates at monitored wetlands.
- Produce third round of pamphlets reporting waterbird data at individual lakes.
- Arrange to publicize results of the monitoring to date through media and presentation to NRM groups.
- Complete delineation of catchment/subcatchment boundaries of monitored wetlands. Obtain high resolution, oblique aerial photography of additional monitored wetlands.
- Undertake bathymetric surveys 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), K. Sutcliffe (0.25), M. Pennifold (0.25); Total (0.65).

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 2004/2005 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 third round of sampling was completed in 2007. Macroinvertebrate identification and water chemistry analysis have been almost completed for these samples.

Management implications
Too early in project to draw conclusions.

Future directions (next 12-18 months)

- Data from the third and fourth round of sampling to be analysed, including use of the AusRivAS model.
- Fourth round of sampling to undertaken in spring 2008.

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 five 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 (one) Wyndham, East Kimberley Region.
    - King Leopold National Park (three) West Kimberley Region.
    - Lorna Glen (one) Goldfields Region.
    - Katanning Agricultural Research Station.
    - Simcocks Private Property (one) 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 enabled preliminary analysis of remote sensing techniques and their applicability to the grasslands of Western Australia.
- Two papers describing progress with the grassland curing study were presented at the Australasian Fire Authorities Council/Bushfire CRC conference in Hobart in 2007.

Management implications

Development of methods for assessing and predicting current and future levels of curing in grasslands, focusing on two main areas, remote sensing applications and pasture (grass) growth modeling.

Future directions (next 12-18 months)

Limited field data collection will continue at southern sites during 2008 and the project will be written up and finalized by mid 2009.

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 five were sampled at each sampling event. Sampling involved complete harvesting of all above-ground biomass by species. At years five 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 analysed.

- 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 seven 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 five, 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 five 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 five species of small herbs characteristic of disturbed sites, of which two 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 seven 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 four to six 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)

This project will be terminated at the end of June 2008.

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# 1993/090

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 two 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 two 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 analysed.
- 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 mild 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)
This project will be terminated at the end of June 2008.

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# 2000/003

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. Mininsterial Condition 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

- Monitoring of groundwater levels, stream flow, stream salinity and stream turbidity in the two treatment catchments and in the control catchment has continued throughout the year.
- The effect of climate change was greater than the effect of timber harvesting and silvicultural treatments on the hydrological response. Groundwater levels were falling during the pre-treatment period and continued to fall after the treatments but at a reduced rate proportional to the reduction in crown cover in each catchment.
- Relative to the control catchment the peak groundwater response was about 1.5 m in the intensive-treatment catchment and about 1 m in the standard-treatment catchment seven years after the treatments
- There was no measurable streamflow or stream salinity response to the treatments, relative to the control, because the falling saline groundwater table disconnected from the soil surface just before the application of the treatments and did not contribute to streamflow.
- The stream buffer was effective in maintaining low stream turbidity in one catchment but an eroding unsealed road in the other catchment delivered sediment by overland flow into the stream at a stream crossing increasing the turbidity.
- A draft report has been written.

Management implications

- This study has established a strong relationship between the magnitude of vegetation reduction and the groundwater response. If the depth to groundwater is known at the catchment outlet then the intensity of forest reduction in a harvest and silvicultural operation may be adjusted so that saline groundwater does not rise to the soil surface.
- This study has confirmed the need to adequately control runoff from roads located within stream buffers to prevent sedimentation of streams

Future directions (next 12-18 months)

- Monitoring of groundwater levels, streamflow, stream salinity and turbidity and rainfall should be continued, at a reduced level, because the data provide a unique long-term record of the hydrological response of IRZ forest to climate change.
- Publish the research.

DEC Region
Swan.

IBRA Region
Jarrah Forest.

NRM Regions
South West, Swan.

Directory of important wetlands in Australia: revised editions

SPP# 1999/014

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 analysed 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 have 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 analysed 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 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# 1999/017

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 two 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 2005/2006 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.
- 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 (0.01) L McCaw (0.05), Frankland District Staff as required; Total (0.26).

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 five years 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.
- A poster and abstract of the analysis of the beetle assemblages presented to the 8th Biodiversity and Invertebrate Conservation conference (Dec 2007) by P Van Heurck (see SPP# 2003/2003).

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 analysed for consolidation in a five 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 impact of timber harvesting on bird populations in south-west forests

SPP# 1994/008

Team Members
I Abbott (0.05), A Mellican (0.05), G Liddelow (0.01), C Vellios (0.01), V Tunsell (0.01), M Williams (0.01); Total (0.14).

Context
Understanding the long-term effects of timber harvesting on bird populations in karri and jarrah forests is important for predicting how bird species and numbers of individuals respond in terms of 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
- The results of bird counts in two plots in Gray forest block (karri forest) in spring 2006 and autumn 2007 were analysed, and integrated with data collected in 1982-3, 1985-9 and 1996-8.
- The results of bird counts in 16 jarrah forest plots in Kingston and adjacent forest blocks in spring 2004, 2005, and 2006 were analysed and integrated with data collected in 1994, 1997-9, and 2000-1.
- A paper - Monitoring of the recovery of bird populations after logging in forests in south-west Western Australia: An update from two long-term experimental research case studies - was written and has been submitted for publication.

Management Implications
- This study evaluates the effect of past silvicultural practices in the karri and current silvicultural practices in the jarrah forests.
- Avifaunal composition of logged and unlogged karri forest was the most similar so far, 21 years after logging took place, but species richness and total abundance remained higher in unlogged karri forest. In jarrah forest, species composition in four treatments (two logged, two unlogged) had not closely converged after 10 years.

Future directions (next 12-18 months)
- Counts at the Gray plots should be repeated less frequently (every 15 years), with the next due in 2021 (36 years after regeneration).
- Counts are scheduled for the Kingston plots in 2011 (15 years after regeneration).
- These plots are now historically significant and have been converted into a long-term monitoring study; they should not be disturbed by logging, and fire management needs to be timed that scheduled bird counts are not compromised by the introduction of confounding factors.

- The data accrued so far provide an important baseline for assessing future impacts from changing climate, and any associated changes in fire regimes and infection by animal disease and *Phytophthora cinnamomi*, as well as for evaluating the ecologically sustainable basis of forest management.

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# 1997/003

Team members
L McCaw (0.3), G Phelan (0.2); 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 analysed 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 paper 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 published in Australian Forestry.
- The final project report was released by the Minister of Environment in November 2007. The 218 page report was accompanied by a six page executive summary, a field guide for fuel

assessment and fire behaviour prediction, and a DVD containing selected video clips illustrating important fire behaviour phenomenon.

- Two experiments studying trends in fine fuel moisture content during dry windy summer nights were undertaken in February 2008 to provide additional data for validation of the Project Vesta fire behaviour model.

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 knowledge transfer program including field-based training in the use of the fuel hazard rating system and the fire behaviour prediction system.
- Publication of scientific papers on fuel description, fire behaviour experiments, flame dimensions and spotting.

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 five years since the last measurement, and 20 years since the experiment was established in a stand that was 13 years 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 three 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 the 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 2008-2011. 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.

Fire induced mosaics in semi-arid shrublands and woodlands

SPP# 1993/086

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.
- Field work was undertaken in July 2007 to examine the age structure of *Callitris preissii* patches in shrublands. This work formed part of an Honours project undertaken by Ms Chloe Flaherty at the University of Western Australia to investigate patch dynamics and flammability of *Callitris*.
- A manuscript describing the potential of *Callitris preissii* for dendrochronology has been submitted for publication.
- Stand structure and tree rings were sampled at nine sites in the Goldfields and southern Murchison during a two week field trip in June 2008 as part of a CERF funded project examining the potential of *Callitris columellaris* as a bio-indicator of decadal scale environmental change.

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.
- Continued participation in the CERF Callitris project.

DEC Regions

South Coast, Goldfields, Wheatbelt.

IBRA Regions

Coolgardie, Esperance Plains, Mallee.

NRM Regions

South Coast, Rangelands.

Identification and monitoring of benthic invertebrate communities of tropical intertidal mudflats

SPP# 1999/015

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 two 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 2006/2007.
- Funding was obtained from DEC's Wetland Project proposals. Initiated analysis of data collected from the Eighty-mile Beach monitoring ('Monanna') Project. Results 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 three 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# 2007/008

Team members
I Radford (0.5), L McCaw (0.05), R Fairman (1.0); Total (1.55).

Context
Recent studies in the Northern Territory have shown declines in CWR mammals (35g-5kg), some bird species and some shrubs. Increased intensity and frequency of fires has been blamed for biodiversity declines in otherwise intact landscapes. Studies in central Australian arid environments also highlight the strong influence of fire, combined with introduced predators, on the abundance of mammal species. This evidence from both the tropical savannas and arid environments has 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 north Kimberley (Mitchell River region), the last mainland stronghold for many threatened critical weight range mammal species. Studies will also address the question of how fire influences critical weight range mammals, through an analysis of vegetation structural and resource dynamics.

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 re-colonization 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. Further work is being undertaken

to increase accuracy on sandstone in high rainfall zones.

- Mammal, invertebrate and vegetation sampling was undertaken (June to Aug 07) at sites with differing time since fire in the Mitchell River region. Laterite (n=10) and sandstone (n=8) sites were sampled. Time since fire ranged from two months to 24 months post-fire. Results show a clear influence of time since fire on abundance of native rodent species. Environmental features most closely aligned with CWR mammal abundance were vegetation structural features, particularly mature shrub density, shrub canopy cover and herbaceous biomass and cover.
- Extremely low numbers of animals caught on laterite, despite high densities in a 2003 survey, show that these landscapes are subject to much greater CWR mammal fluctuations than sandstone environments. This suggests that laterite will be more susceptible to declines associated with frequent fire.
- More detailed study of eight sandstone sites, four within a fine-grained fire mosaic, and four outside, will be used to further elucidate the role of vegetation structure and resource dynamics in determining CWR mammal abundance. Six sites in the Mitchell region have been established, with another two to be established in August 2008. Initial results show that CWR mammal populations have declined in areas subject to coarse-scale fire mosaics, suggesting that even sandstone environments are threatened by broadscale dry season fires. This is despite permanent shelter provided by rocks. This raises the question of whether remote sandstone areas of the north Kimberley are refuges for CWR mammals, or whether refuges may be provided by “fire-shadow” areas, including camp grounds, where active fire suppression and intensive prescribed burning protects them from large, intense fires.
- Across permanent monitoring sites, 49 northern quolls, 20 common rock rats, 10 northern brown bandicoots and eight golden bandicoots were micro-chipped for monitoring of life history parameters in fine and coarse mosaic sites.

Management implications

Results to date suggest that a number of rodent species prefer areas with 18 months or more post-fire. This means older vegetation patches need to be retained within savannas to facilitate recovery and persistence of CWR mammals. Results show that protection from large scale dry season fires, through suppression activities and targeted prescribed burning (e.g. around camp grounds) can provide refuges for CWR mammals. These areas should be expanded to increase refuge size to improve resilience of mammal communities in a given area.

Future directions (next 12-18 months)

- Establish two further long-term monitoring sites at Mitchell for detailed analysis of habitat structure and resource dynamics (Aug 2008).
- Better quantify CWR mammal resources to include analysis of fire effects on grass seed production, which provide resources for rodent species. Also large invertebrates/small vertebrates will be sampled as food for northern quolls and bandicoots.
- Measure survival, fecundity and recruitment are planned in August 2008 and March 2009, with ongoing monitoring planned for the next several years.
- Monitoring of micro-chipped animals, invertebrates/small vertebrates at Mitchell sites (Aug 2008).
- Quantification of *Triodia* spp. seed production (Dec 2008).
- Wet season monitoring of micro-chipped animals, invertebrates/small vertebrates Mitchell sites (Mar 2009).
- 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.

NRM Region
Rangelands.

Armillaria spread in karri
SPP# 1998/006

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 regrowth karri 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
- Stump pulling as a control measure has been undertaken in Warren block.
- Review paper published.
- Six long-term monitoring plots have been 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)
- Prepare plan for 2nd thinning of plots in the Warren Thinning Experiment.
- Long-term monitoring plots to be assessed every five years in Warren block.

DEC Region
Warren.

IBRA Region
Warren.

NRM Region
South West.

The effect of wildfire on fungi

SPP# 1998/015

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 10 year post-fire assessment was completed in 2007.
- 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 five years. Fire mosaics have the potential to enhance fungal diversity across a landscape.
- Scientific paper in press with Austral Ecology - The succession of macrofungi following a wildfire in karri regrowth forests in Western Australia.
- Scientific paper published - Preliminary list of macrofungi recorded in burnt and unburnt *Eucalyptus diversicolor* regrowth forest in the south-west of Western Australia: 1998-2002.
- Scientific paper presented - Assessing the risk of fire assists fungal survey in the southwest of Western Australia.

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 data to be analysed.
- 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.
- Review paper accepted for publication in Australian Forestry - Forest health surveillance in Western Australia: A summary of major activities from 1997-2006.
- Lists of pests and diseases and their respective extent and impact in native forests and plantations were prepared for inclusion in the 2008 State of the Forests report.

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# 2007/009

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 two 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

- SPP approved, incorporating suggestions received from SFM staff.
- A pilot trial was set up in recently thinned forest, and the design was modified as necessary.
- Four permanent paired Trial sites have been selected, and fully replicated trials are being set up for initial measurement.

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)

- Complete initial assessments and measurements on the first four trials; analyse data.
- Continue site selection and establishment of trials at different sites, and carry out initial assessments and measurements.
- Commence Year two measurements on the first four trials.

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# 2003/003

Team members
P Van Heurck (0.09), I Abbott (0.02), A Mellican (0.02); district staff - E Middleton; Walpole-Nornalup Parks Association and Walpole community volunteers; Total (0.13).

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 Jacqueline 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 colored 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.
- An article on the role of the local volunteers in this project published.

- A handbook published - 'Beetles of the Walpole-Nornalup National Park'.
- T Havik a scientific illustrator from the Netherlands is currently preparing drawings of the new species found.
- A poster and abstract of the analysis of the beetle assemblages presented in Dec 2007.

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 a four year period. 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, such as the Bushfire CRC and Boranup Fire study.
- 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# 1993/115

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 2004/2005 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 three standardized transects was maintained at six 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)

- Re-trap fauna monitoring grids in 2008-2009.
- 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 (*Corymbia 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# 1993/095

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 dependent species from the jarrah forests.
- To establish the relationship between tree size and tree age for jarrah and marri trees and 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 and 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 and determine the relative size of hollows used by all hollow dependent 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 and 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 and 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 and the potential for modeling of recruitment, decay and removal of logs from the forest floor.
- To identify the types and sizes of log hollows 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 the analysis of CWD data from plots at two sites in the jarrah forest that have never been logged.
- Added data from two new plots to the data originally collected by K Faunt and re-analysed the combined dataset.
- Presented findings from this study of CWD at *Old Forests New Management* conference in Hobart.
- Prepared a draft manuscript covering this study of CWD.

- Following the findings from this study of CWD, additional measurements were collected from a subset of the FORESTCHECK CWD transects. This data will be used to further examine the available volumes, structure and decay of CWD.

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)

- Progress the draft manuscript based on the CWD study.
- The FORESTCHECK plot set is now being used to collect data for this study. FORESTCHECK plots in the Swan region will be surveyed in the next 12 months to further enhance this dataset.

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 was completed and approved 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)

- Complete the publication of manuscript on adaptive trials of cording.
- Revise and submit three 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# 1993/094

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.
- Twenty-two 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# 1993/097

Team members

A Wills (0.01), P Van Heurck (0.01) Total (0.02).

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# 2001/005

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 alpha and beta 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 five yearly intervals is recommended, unless expansion of outbreak eventuates sooner. Next monitoring due 2009. Survey October 2009, complete report April 2010.

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), C Carpenter (0.1), J. Hollis (0.1), P. Van Heurck (0.1), A Wills (0.2); Total (2.8).

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 five decades.

Summary of progress and main findings

- The field work and data collection component of the project is more than half-way through, with invertebrate sampling and forest structure measures now completed.
- Invertebrate collections for spring 2006, autumn 2007, spring 2007 and autumn 2008 are complete, with the final two requiring species identification.
- Vertebrate fauna trapping (Sheffield and pitfall traps) has been completed for autumn 2007, spring 2007 and autumn 2008 and data entered. The final trapping session is in spring 2008.
- Fungi surveys were undertaken in May-July 2007, and are underway for the 2008 survey at the time of writing. This will complete the survey component for fungi.
- Floristic surveys on all 30 plots were completed over October-November 2007. Voucher

specimens are currently being processed and identification of some taxa is on-going.

- A site description and soil sampling protocol is currently underway to provide accurate environmental data for each site.
- Five weather stations were installed in November 2007 spanning the geographic range of the study area.
- A manuscript submitted to Proceedings of the Royal Society of Queensland on the GIS mapping of fire interval sequences (Proceedings of the Bushfire 2006 conference) is currently in press.
- A manuscript describing the assembly of the fire history data for the Warren Region has been submitted to Conservation Science Western Australia.

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)

- Complete final fungi survey in July 2008.
- Complete floristics work by surveying in summer for summer-flowering taxa.
- Complete final vertebrate survey in November 2008.
- Complete soil classification work.
- Attend the joint Bushfire CRC and Australasian Fire Emergency Service Authorities Council (AFAC) conference in Adelaide, September 2008 and present results from the first year of data collection for a paper in the proceedings.
- Manuscript preparation for the following components of the study:
    - Literature review on fire regime effects on biota.
    - Description of the fire history for the Warren Region.
    - General methodology (designing retrospective studies of fire history on biota).
    - Fire regimes and invertebrates
    - Fire regimes and vertebrate fauna
    - Fire regimes and fungi
    - Fire regimes and floristics
    - Synthesis of the study.

DEC Region
Warren.

IBRA Region
Jarrah Forest, 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 (0.1), C Gosper (1.0); Total (1.1).

Context

Application of an ecological approach to fire management in DEC-managed conservation reserves, 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 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 and 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 do current fire management methods, such as scrub rolling, affect native plant communities?
    - How does fire and associated disturbances influence weed invasion in eastern wheatbelt plant communities?

Summary of progress and main findings

- Vegetation community composition, cover and structure have been sampled across a time-since-fire gradient in two widespread plant communities, tallerack mallee-heath and mallee. Community composition is substantially different between long unburnt plots and plots recently scrub rolled and / or burnt.
- Recruitment of representative taxa from different plant functional types have been sampled in scrub rolled and burnt strips and adjoining areas solely burnt. Recruits of serotinous obligate seeding species (*e.g.* many *Dryandra* and *Hakea*) were significantly less abundant in scrub rolled plots compared to plots solely burnt. Recruitment of other plant functional types (serotinous resprouters, and resprouters and obligate seeders with a soil-stored seed bank) was largely unaffected.
- An experiment testing the relative importance of propagule pressure, landscape context (edge effect) and disturbance by fire in driving annual grass invasions is in the process of being established.

Management implications

An improved understanding of the ecological impacts of scrub rolling should lead to more informed decisions on their use in fire management, such as their location and what mitigation methods may be appropriate to ensure the persistence of vulnerable serotinous, obligate seeding species.

Future directions (next 12-18 months)

- Investigate differences in fire regime with remnant size, landscape context and clearing history.
- Identify candidate species for use in case studies to determine acceptable upper and lower limits in the temporal variability in fire regimes for each plant community. Plant population demographic changes with time since fire will be measured.

- Complete study on annual grass invasion after fire.
- Complete manuscripts on scrub rolling, and vegetation community 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

NorthWest Marine Research Inventory (NWMRI)

Core Project

Team members

K Waples (0.1); C Simpson (0.1); Total (0.2)

Context

The Commonwealth has initiated its northwest marine bioregional planning exercises and, in conjunction with WAMSI has generated support for the development of a metadata database of all completed, current and planned research in the marine and coastal environment from Kalbarri to the Northern Territory and extending out to the Economic Exclusion Zone (EEZ). This project has become part of the science plan for Node 3 of WAMSI and, as such is being coordinated by the DEC. A project team from CSIRO are undertaking the work.

Aligns with Corporate Strategies 2007-2009: 8.3, 1.2

Summary of progress and main findings

- Steering Committee to guide research initiated.
- Project proposal approved by steering committee and WAMSI.
- Project agreement signed and in place.
- Project team developed database to house the metadata consistent with Australian and international marine metadata standards.
- Project team in the process of collecting metadata from research bodies, government and industry.

Management implications

The completed database will provide a valuable resource for government agencies to identify what research has been undertaken in the marine environment and who holds the relevant information. This will help direct future research programs to fill gaps rather than repeat existing work.

Future directions (next 12-18 months)

Ensure the database is maintained and made broadly available through an internet site.

DEC Region

Kimberley, Pilbara, Midwest.

IMCRA Region

North West Coast, Central West Coast.

NRM Region

Rangelands.

Comparative marine biodiversity survey of the Rowley Shoals

SPP to be allocated

Team members

S Long (0.70), S Armstrong (0.05), S McKenna (0.05); Total (0.80).

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 reef biodiversity conservation.

Successful management requires informed decision-making. Information 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 three shoals. Monitoring of human impacts as manifested in changes in marine biodiversity over time will facilitate best possible management of the Rowley Shoals.

DEC was one of the two major collaborative partners in a major marine biodiversity survey that ran from 1-17 December 2007. The results and outputs produced by DEC and collaborators will be of direct relevance to management of sharks and benthic assemblages (including commercially important invertebrates), not only at the Rowley Shoals but elsewhere in tropical Western Australia.

Aligns with Corporate Priorities 2007-2008: 3, 5, 11, 12. KRAs NC 2B, 2E, 2F, 2G, 2I, 2J.

Summary of progress and main findings

- Draft SPP and field program prepared; Survey completed; Metadata report in progress.
- Keyword-searchable database of WA Museum collections from WA's oceanic shoals in draft and on schedule.
- Draft basic photo ID field guides for algae and soft corals (to be used by DEC monitoring teams working in WA's tropical marine environments).
- Positive media coverage for DEC and AIMS associated with cruise.

Management implications

- Increased public awareness of conservation value of the Rowley Shoals.
- Increased awareness in federal agencies (DEWHA, Coastwatch) of need for vigilance against poaching.

Future directions (next 12-18 months)

- Positioning of the Rowley Shoals as global marine biodiversity conservation benchmarks, through DEC-led publication of a book describing the results of recent research at the Rowley Shoals.
- Science planning for investigations into causes of apparent coral pathology at the Rowley Shoals

DEC Region

Kimberley.

IMCRA Region

Offshore Oceanic Shoals.

NRM Region

Rangelands.

Distributions and patterns of major benthic communities of the Montebello/Barrow Island marine protected areas (MBIMPA)

SPP# not yet allocated

Team members

K Bancroft (0.35), S McKenna (0.05); Total (0.40). A Kendrick (0.10), C Samson (0.05); Total Pilbara Region (0.15).

Context

The Montebello/Barrow Islands marine protected areas (MBIMPA) were gazetted in April 2007. Coral reef communities, mangroves, and macroalgal and seagrass communities are identified as key performance indicators in the management plan. However, the current understanding of marine ecological communities in the Montebello/Barrow islands marine protected areas (MBIMPA) is limited. The existing marine benthic habitat map was developed for the reserve planning process, at a resolution that is too broad to determine patterns in distributions and diversity.

This project will further develop a better understanding of marine biodiversity patterns within the MBIMPA. New data, in the form of field surveys, high resolution bathymetry, ortho-aerials and modelled benthic habitat will be used in conjunction with existing remote sensing and ground truth habitat data, to determine the distribution and diversity of major marine benthic communities in the MBIMPA. The data gathered and compiled through this project will form an essential information layer, to assess the appropriateness of existing management zoning, to assist in the environmental impact assessment of future development and to assist decision making for the ongoing management of the MBIMPA.

Aligns with Corporate Priorities 2007-2009: 1.2, 2.3 and KRAs 1, 2, NC priorities 3, 4 and PVS priorities 2A

Aim

To improve the understanding of the distribution and diversity of the major marine benthic communities in the Montebello/ Barrow Islands marine protected areas.

Summary of progress and main findings

- Ongoing liaison with Apache Energy Ltd and Chevron Australia Pty Ltd in regards to long-term monitoring data exchange and access to the spatial data such as habitat ground-truth data.
- Provided advice to the Environmental Management Branch on benthic habitat mapping and classification, and dredging monitoring program for the proposed gorgon Gas development.
- Analysis of benthic community data collected during the December 2006 survey was completed.
- Data Report for the December 2006 survey is being finalized.
- Management tools presented as a series of maps are being prepared. The series includes an enhanced ortho-aerial map, one-metre bathymetry map and a benthic habitat ground truth map.
- A presentation on the regional significant reef complex within the MBIMPA was given at the Australian Coral Reef Society Conference in Oct 2007.
- Contributed to the draft National Intertidal/Subtidal Benthic Habitat Classification Scheme as part of the Australian Coastal Vulnerability Project, supported by the Australian Greenhouse Office and the National Land and Water Resources Audit.
- Participated in a collaborative survey for *Porites* colonies in the Montebello/barrow Islands MPAs, West Pilbara islands and Ningaloo Marine Park were colonies were identified for the possible inclusion in an intensive west coast coring program to be undertaken by the Australian institute of Marine Science.
- Further habitat data was collected during the above survey.
- A DEC matters news article on the above survey was published online in February 2008.

Management implications

- The provision of information that assist in addressing Montebello/Barrow Islands Marine Conservation Reserves Management Plan 2007-2017 strategies: 7.6 (2); 7.6 (4); 9.1.3 (5); 9.1.4 (3); 9.1.5 (4); 9.1.6 (3); 9.1.6 (6); 9.1.7 (3); 9.1.7 (5)*;* 9.1.8 (5)*;* 9.1.9 (4)*;* and 9.1.9 (5).
- Increase understanding on the condition of the coral reef, reef fish and corallivorous invertebrates communities of the Montebello/ Barrow Islands marine protected areas.
- Increase understanding on the distributions of marine benthic communities of the Montebello/ Barrow Islands marine protected areas.
- The identification of *Porites* coral colonies suitable for effects of climate change research to be undertaken by AIMS.

Future directions (next 12-18 months)

- Completion and distribution of the survey Data Report and of the map series for use as a management tool.
- Prepare a technical report.
- Development of generic approach to habitat mapping and marine biodiversity inventory surveys.
- Undertake further benthic habitat data acquisition.

DEC Region
Pilbara.

IMCRA Region
Pilbara Offshore.

NRM Region
Rangelands.

Establishing a long-term monitoring program for the proposed Dampier Archipelago Marine Park

SPP# 2008/002

Team members
S Armstrong (0.3), S Long (0.05), A Edwards (0.01); Total (0.36); A Williams (0.01), G Kregor (0.01), B Daw (0.01) A Kendrick (0.05); Total Pilbara Region (0.08).

Context
The proposed Dampier Archipelago Marine Park (DAMP) is located off the north-west coast of Western Australia approximately 1,650 km north of Perth. The area comprises of a wide range of marine habitats that support diverse marine biota, including more than 736 fish species and 230 scleractinian coral species, making the Dampier Archipelago the second most diverse site in Western Australia for hard corals. The marine environment of the area has considerable regional ecological and social conservation significance and is subject to increasing human use, including major offshore oil and gas production and associated port development. The region is also subject to a range of commercial and recreational fishing activities and the Dampier area has the highest per capita boat ownership in Western Australia.

Trends in resource condition over time are essential for assessment of the effectiveness of the proposed management regime for the DAMP. This project has established long-term monitoring sites, using a BACI design, to obtain data on the abundance of selected finfish species and the cover of benthic reef communities ‘before’ the zoning scheme is implemented. These data will provide estimates of the current condition of the reef and reef finfish populations at selected sites to compare with future data following the establishment of the DAMP and the implementation of the

zoning scheme (i.e. comparisons between sanctuary and non-sanctuary zones). The data will also be compared to historical data to provide a longer-term temporal perspective.

Aligns with Corporate Strategies 2007-2009: 1.2, 2.3, 2.4, 7.1, 7.6, 8.1, 8.4, 8.5; KRAs: KRA1 KRA2

Summary of progress and main findings

- Concept Plan, Project Plan and Field Operations Plan completed.
- Two field surveys completed.
- Data analysis completed.
- Data Report draft completed.
- Pilbara News newspaper article.
- DEC Conservation News article.
- LANDSCOPE article completed.

Management implications

- The project will provide information trends in resource condition over time for assessment of the effectiveness of the proposed management regime.
- Increase understanding on the condition of Dampier Archipelago coral reef communities.
- Increase understanding on the condition of Dampier Archipelago reef fish communities.
- Increased public awareness of conservation value of the Dampier Archipelago.

Future directions (next 12-18 months)

- Complete statistical analysis of data.
- Complete data report
- Complete technical report/paper.

DEC Region
Pilbara.

IMCRA Region
Pilbara Nearshore.

NRM Region
Rangelands.

Three-yearly Ningaloo *Drupella* survey

SPP# 2008/002

Team members

S Armstrong (0.2), Total (0.2); C O'Callaghan (0.05), A Whitford (0.05), H Dilley (0.02), B Halkyard (0.01), M Smith (0.01), R Mau (0.01); Total Pilbara Region (0.15).

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 areas. 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 other reefs elsewhere in the world to date.

As the health of coral communities is a key performance indicator of management of NMP and the Muiron Islands Marine Management Area (MIMMA), it is essential to keep a watching brief on spatial and temporal changes to *D. cornus* densities and cover of associated corals in these conservation reserves. Adhering to this management need, the aim of the Ningaloo Marine Park *Drupella* Long-term Monitoring Program (NMPDMP) is to monitor long-term changes in the density of *D. cornus* and cover of associated coral communities at the NMP and the MIMMA. Monitoring of *D. cornus* at NMP has produced a long-term data set with information describing the status of *D. cornus* populations and coral communities dating back to 1987.

A strategy in the Ningaloo Marine Park Management Plan 2005-2015 requires that *D. cornus* abundance and the health of coral communities be surveyed at least every three years. A major survey was due and undertaking in 2008.

Aligns with Corporate Strategies 2007-2009: e.g. 1.2, 2.3, 2.4, 7.1, 8.1, 8.4, 8.5; KRAs: KRA1 KRA2.

Summary of progress and main findings

- The results of the surveys indicate that between 1987 and 2008 the direction and amplitude of change in *D. cornus* density and percent cover of live hard coral has varied considerably between locations. Overall however, relative to the outbreak densities recorded during the late 1980s and early 1990s, *D. cornus* densities have been low to moderate since 1994 and have not greatly affected coral cover at the NMP and MIMMA.
- The findings of the 2008 survey support this trend and suggest that current *D. cornus* densities represent no immediate threat to NMP and MIMMA coral communities.

Outputs

- Concept Plan, Project Plan and Field Operations Plan completed.
- 2008 major field survey completed.
- Current *D. cornus* densities represent no immediate threat to coral communities at NMP or MIMMA.
- Pilbara News newspaper article.
- Landscope magazine article.
- Northern Guardian newspaper article.
- Exmouth Expression community newspaper article.
- Google Earth layer drafted.
- Presentation at the Australian Coral Reef Society Conference
- Presentation at the 2007 Annual Ningaloo Symposium
- DEC media release
- Radio broadcast – ABC NW Karratha
- Radio broadcast – ABC Midwest Wheatbelt Geraldton

Management implications

- *D. cornus* populations pose no immediate threat to coral communities at NMP or MIMMA.
- Mechanical damage to corals (e.g. during boating and diving activities) may attract *D. cornus*:
- It is recommended that a simple education pamphlet be developed and distributed by Exmouth District as soon as possible to encourage more sustainable diving and boating practices to address this issue.

Future directions (next 12-18 months)

- Complete data and statistical analysis.
- Complete Data Report, technical report and paper.
- Complete Google Earth layer.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Coral Bay reef recovery study/ annual coral spawn observations

SPP# not yet allocated

Team members
S Armstrong (0.1), S Long (0.01), Total (0.11); R Syme (0.5), C O'Callaghan (0.01), A Whitford (0.01), M Smith (0.01), Total Pilbara Region (0.53).

Context
In 1989, a novel form of disturbance *was recorded at Bills Bay* in *WA*: unusually calm wind and sea conditions coincident with mass coral spawning caused a dystrophic crisis as the respiratory demand of the spawn slick followed by its decomposition depleted available oxygen in the water column and sediments. Up to 100% of corals, fishes and reef invertebrates died at some sites during this event, including colonies up to 50 years old, indicating that a mass mortality of this magnitude had not occurred for at least four to five decades. Anecdotal reports of less severe anoxic events at Bill's Bay coincident with coral spawning on several occasions since 1989 indicate that such events may not be uncommon in this location. Since 1989, the recovery of coral reef communities at Bill's Bay has been monitored. Findings from a survey in 2006 indicated that recovery of pre-disturbance levels of coral cover occurred within 10 years, and recovery of pre-disturbance type acroporid-dominated coral communities was achieved at one site within 17 years. Most recovering near-shore sites had not yet reached this successional stage by 2006.

In March 2008, the most severe anoxic event to occur since 1989 was recorded at Bills Bay. Hundreds of dead fish washed up along the shore at Bill's Bay and an estimated 30 to 60% of corals bleached over an area of approximately 1.3km^2. A major field survey will be undertaken at Bills Bay in mid 2008 to determine the extent of coral mortality from this event.

Aligns with Corporate Strategies 2007-2009: 1.2, 2.3, 8.4, 8.5; KRAs: KRA1 KRA2

Summary of progress and main findings
- Field survey completed.
- Data Report draft completed.
- Two draft papers completed.

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)
- Finalize Data Report.
- Undertake major field survey in mid 2008.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Mapping of the coral reef communities of Shark Bay MPAs

SPP# not yet allocated

Team members
K Bancroft (0.15), S McKenna (0.02); Total (0.17). T Grubba (0.10), W Moroney (0.10); Total Shark Bay District (0.20).

Context
While the Shark Bay Marine Reserves Management Plan 1996-2006 (Department of Conservation and Land Management 1996) is anticipated to be reviewed within the next year, The Shark Bay Terrestrial Reserves Management Plan 2000-2010 (Department of Conservation and Land Management 2000) and the Shark Bay World Heritage Property Strategic Plan (Department of Environment and Conservation 2006) are currently being reviewed. This planning activity provides a window of opportunity for increased technical understanding to immediately inform management, for example, by identifying areas of high conservation value as well as potential human interactions with these values.

The distributions of perennial seagrass meadows in the Shark Bay marine protected areas (SBMPA) are reasonably well understood, there are very few data on ephemeral seagrasses and mangals, and no data on other important benthic communities such as coral reefs, filter-feeders, stromatolites, subtidal reef platforms, beaches, rocky shore or intertidal shoreline reef. Although marine ecological communities are of high conservation value in the SBMPA and the proposed extensions, our understanding of their distributions is limited. The spatial scale of the existing marine benthic habitat map is, not at an adequate scale (i.e. too broad) in some areas of the SBMPA, for MPA management or environmental impact assessment.

New data obtained by this project, in conjunction with existing aerial photogrammetry and satellite imagery, will increase the current understanding of the distribution and diversity of coral reef communities in the SBMPA. The data gathered and compiled through this project will be presented as GIS information layer for use in the planning phases and the ongoing management of the SBMPA and the proposed extensions.

Aligns with Corporate Priorities 2007-2009: 1.2, 2.3. KRAs 1; 2. NC priorities 3; PVA 1A; 2A

Aim
To improve the understanding of the distribution and diversity of coral reef communities in the Shark Bay marine protected areas.

Summary of progress and main findings
- A collaborative field program with the Shark bay District, was undertaken to collect data on the distribution and diversity of coral reef communities in the Shark Bay MPAs.
- The collected ground-truth data has been analysed and databased in the Habitats database.
- Preparation of a data report is underway.
- A draft Landscope article has been submitted and is planned for the Spring 2008 issue.

Management implications
- This project directly addresses Shark Bay Marine Reserves Management Plan 1996-2006

(Department of Conservation and Land Management 1996) management strategies: 5.3 (1); 5.3 (3); 5.5.1 (2) and 11.0 (6).

- Increase understanding on the distribution patterns of the coral reef communities of the Shark Bay marine protected areas.

Future directions (next 12-18 months)

- To finalize and distribute the Data Report for the February 2008 survey.
- Complete and distribute map highlighting the coral reef communities data.
- The completed Landscope article of the February 2008 survey published in the Spring issue.
- Undertake ongoing benthic habitat data acquisition in [particular at Bernier and Dorre Islands.

DEC Region
Mid West.

IMCRA Region
Shark Bay.

NRM Region
Rangelands.

Analysis of existing monitoring data in Jurien Bay Marine Park

SPP# not yet allocated

Team members
K Bancroft (0.15), S McKenna (0.05); Total (0.20). K Crane (0.20), Total Moora District (0.20).

Context
A significant amount of research and monitoring has occurred in the Jurien Bay Marine Park (JBMP) since the beginning of the reservation planning process in 1996 and the gazettal of the park in 2005.
At the launch of the park in 2005, the State Government made commitments to:

- Undertake research to examine the impacts of the rock lobster fishing on the biodiversity of the marine park; and
- Undertake research that would contribute to an understanding of the effectiveness of management zoning.

Since gazettal, there have been numerous research and monitoring projects that have been undertaken by scientists based in State and Commonwealth departments or agencies and several universities, such as WA Museum, Department of Fisheries and the Department of Environment and Conservation, University of Tasmania, University of Western Australia, Edith Cowen University, Murdoch University and CSIRO. A $10 million joint State Government and CSIRO initiative "*Strategic Research for the Marine Environment*" (SRFME) involved research that investigated fauna and flora distributions, coastal processes, physical and biological oceanography, nearshore water quality, benthic communities, commercial and recreation fishing impacts/trends, passive human usage patterns and effectiveness of management zoning. A continuation of SRFME has been incorporated into the $21 million Western Australian Marine Science Institute (WAMSI) as a component of Node 1 "*Strategic research on Western Australian marine ecosystems*".

Activities of this project will include the collation of specific literature relevant to JBMP, recent and current research, and the collation and analysis of appropriate data. This project will provide monitoring information suitable to feed into the marine park management reporting framework for delivery to the Marine Parks and Reserves Authority (MPRA) audit process and the opportunity to assess the gaps in knowledge and to target research and monitoring in priority areas.

Aligns with Corporate Priorities 2007-2009: 1.2, 2.3, KRAs 1, 2, NC priorities 3, 4; and PVS priorities 2A.

Aim

- To identify all ecological and social research that has been undertaken in the reserve in recent years.
- To analyse these data, to provide monitoring information suitable to feed into the marine park management reporting framework for delivery to the Marine Parks and Reserves Authority (MPRA) audit process.

Summary of progress and main findings

- Developed a metadatabase for research and monitoring relevant to the Jurien Bay Marine Park.
- Contribution and liaising with the Jurien bay District to prepare the Draft MPRA Audit report card.
- The analysis of data is nearly finalized and the preparation of a Technical Report is underway.
- Provided input to the draft report on the scientific basis for and the role of marine sanctuaries in marine planning, a report to the expanded Inter-Departmental Committee on Management of the State's Marine Protected Areas.
- Contributions to the 2007 report on the JBMP biodiversity monitoring are being provided to the University of Tasmania.

Management implications

- Addresses the JBMP Management Plan 2005-2015 (Department of Conservation and Land management 2005) management strategies: 8.4 (1); 8.4 (3); and 8.5 (1).
- Provision of more quantitative data input describing the condition, pressure and management response relative to the values of the JBMP (the JBMP report card to the MPRA).
- Provision of current resource condition data into the MPRA audit process, will also assist in the prioritization of further research and monitoring in JBMP.

Future directions (next 12-18 months)

- The finalization and distribution of the Technical Report.
- The finalization and distribution of the University of Tasmania 2007 report.
- The completion of a Technical Report and/or paper on Jurien Bay water quality.

DEC Region
Mid West.

IMCRA Region
Central West Coast.

NRM Region
Northern Agricultural Catchment.

Annual monitoring of KPIs and SZ effectiveness in metropolitan MPAs

SPP# not yet allocated

Team members
S Armstrong (0.07); Total (0.07); P Sutton (0.02); Total Swan Coastal District (0.02).

Context
A strategic framework for marine monitoring in the metropolitan marine parks was developed by DEC in January 2005. During this process the conservation and socio-economic significance of the

values of the Parks were prioritized using a value/threat framework. Values identified as having the highest priority and most threatened by anthropogenic impacts were classified as Key Performance Indictors (KPIs). The conditions of KPIs are a measure of the overall effectiveness marine park management. For each KPI there are short-term and long-term targets, which can be audited.

An evaluation of existing Metro Marine Park monitoring projects in terms of method suitability and data usefulness needs to be undertaken in order to successfully design and implement a long-term monitoring program for the metropolitan Marine Parks. This monitoring program will then provide the quantitative data necessary to identify trends in Metro Marine Park KPI conditions over-time and assess whether established management targets of KPIs are being met.

Aligns with Corporate Strategies 2007-2009: 1.2, 2.3, 8.4, 8.5; KRAs: KRA1 KRA2

Summary of progress and main findings

- Concept Plan completed.
- Evaluation of existing projects methods and data underway.

Management implications

- The project will undertake strategic planning and evaluation to design a long-term monitoring program that will provide scientifically robust data on KPIs of management of the Metro MPAs.
- The second phase of the project will be to undertake this monitoring to provide information trends in resource condition over time for assessment of the effectiveness of the Metro MPA management regimes.

Future directions (next 12-18 months)

- Continue the evaluation process of existing project methods and data.
- Complete “way forward for Metro MPA monitoring” guideline paper.

DEC Region
Swan.

IMCRA Region
Central West/Leeuwin Naturalist.

NRM Region
Swan Catchment /South West Catchment.

Science Coordination and Administration of WAMSI Node 3 and Integration across WAMSI and with the Wealth from Oceans Collaboration Flagship project: the Ningaloo Cluster

Core project

Team members
K Waples (0.55); C Simpson (0.2); Total (0.75).

Context
In 2005 the Premier allocated $5million to undertake research at Ningaloo Marine Park that would underpin its management. A Ningaloo Research Program (NRP) was developed in consultation with marine resource managers and scientists to address key strategies in the Ningaloo Marine Park Management Plan. In 2007 a joint research body, the Western Australian Marine Science Institution was formed and provided with substantial government funding. Research within WAMSI was divided into several themes, each with a lead agency. The DEC is the leader of Node 3 of WAMSI which addresses research in marine biodiversity and conservation. The NRP was accepted as the initial

science plan for Node 3 of WAMSI and the $5million allocated to this research was made part of the government support to WAMSI.

At the same time as the development of the NRP, CSIRO Wealth from Oceans Flagship program created a research program around Ningaloo marine Park called the Ningaloo Cluster. This research program is designed to complement the NRP and fill in research gaps. In addition, AIMS has a number of research projects underway at Ningaloo as part of their core research.

DEC is working together with AIMS and representatives from the Ningaloo Cluster to ensure that the planned research takes place, is directed so that it will meet management needs and is properly integrated and communicated so that this body of research will be recognized and taken up in future management and planning initiatives as well as within the science community.

Aligns with Corporate Priorities: 7.1, 7.6, 8.4, 8.5 and KRA2 NC2E.

Aim

- To ensure the coordination and administration of the research program conducted under Node 3 of WAMSI.
- To ensure the integration of this research program with other research within WAMSI and with external programs relevant to the Ningaloo Marine Park.

Summary of progress and main findings

- Node 3 Science Plan complete and approved.
- 7 project agreements in place and projects underway.
- Milestone reports received from the projects underway demonstrate that research is on track and is producing relevant findings on sanctuary zones, biodiversity, oceanographic processes and habitats.
- The Ningaloo Research Coordinating Committee established to address integration of research, data management and science communication for WAMSI, the CSIRO Wealth from Oceans Flagship program: the Ningaloo Cluster and AIMS.
- Ningaloo Research Database updated and 2007 report prepared.
- The Ningaloo website created jointly with the CSIRO.
- Numerous presentations of the Node 3 science plan and specific research projects.
- Ningaloo Research Communication Plan produced and Ningaloo Research Symposium held in July 2007 and May 2008. Proceedings produced.
- Pilbara Region staff and community briefed on Ningaloo.

Management implications

A key role of this project is to ensure that outcomes of the research both within the NRP and from external research programs is reviewed and used in refining and updating management of the Ningaloo Marine Park through changes to policy, management activities and planning exercises where relevant.

Future directions (next 12-18 months)

- Continue to monitor progress of the various research projects and communicate findings and information as it becomes available.
- Continue to interact with the NRCC and develop joint communication activities to further integrate the research programs.
- Develop a knowledge transfer framework to facilitate better transfer of science into policy, planning and management of Ningaloo marine Park.
- Complete a Ningaloo Research Program Progress Report.

DEC Region
Pilbara.

IMCRA Region
Ningaloo.

NRM Region
Rangelands.

Finalize Strategic Research Fund for Marine Environment carry-over projects

Core function

Team members
K Waples (0.03); C Simpson (0.01); Total (0.04).

Context
At the conclusion of the SRFME there were six projects that remained unfinished. The majority of these addressed biodiversity issues at Jurien Bay Marine Park and included studies on ecological interactions in the marine park, primary production and fish communities as well as final documentation and archiving of the data. These projects were handed over to the DEC to manage to completion under the coordination of the Marine Science Program. Although several projects have experienced delays due to personnel issues, all projects are due to be completed by December 2008. This aligns with Corporate Priorities: 8.4, 8.5.

Summary of progress and main findings
- Final reports for two projects received.
- Final reports for the remaining four projects expected by Dec 08.

Management implications
The milestone and final reports for each project will be reviewed for their implications to management and changes recommended to management practices, policies and planning activities where relevant.

Future directions (next 12-18 months)
Continue to monitor progress of the various research projects and communicate findings and information as it becomes available.

DEC Region
Mid West.

IMCRA Region
Central West Coast.

NRM Region
Northern Agricultural Catchment.

SCIENCE APPLICATIONS

Program Leader: Mr Paul Gioia

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.
- Draft papers on plant species richness and endemism close to completion, awaiting final input from coauthor.
- Fauna richness study commenced, awaiting further fauna datasets to support analysis.

Management implications

Species richness and endemism maps are regularly used in DEC planning.

Future directions (next 12-18 months)

- Develop a set of richness and endemism indices for vertebrate fauna.
- Assess data capacity to analyse richness within faunal groups.

DEC Regions

South West, Warren.

IBRA Regions

Jarrah Forest, Warren, Avon Wheatbelt.

NRM Regions

South West, Northern Agricultural.

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 2007/2008, NatureMap received an additional $40 000 of DEC funding through the Save Our Species initiative to continue development of the project.
- NatureMap was soft-launched in December, 2008. Preparations are now underway for a Ministerial launch in the second half of 2008.

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.
- Investigate options for using NatureMap platform in citizen science context.

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 within the next twelve months. 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), P Gioia (0.05).

Context

This project is part of the Natural Diversity Program within the Avon Investment Plan, 2005 (Avon Catchment Council).

This project aligns with Corporate priorities 1 (Conserving Biodiversity) and 7 (Community Involvement and Support) and KRA 1 (NC 1A), 2 (NC 2B, NC 2G, NC 2I), 3 (NC 3H), 4 (NC 4C, NC 4D).

Aim

- 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.

- To collate, analyse and disseminate Avon biodiversity relevant data. This project has now been extended to develop a strategic conservation plan to direct the Avon Catchment Council's natural diversity funding and also to develop and maintain monitoring and evaluation across all the Avon's natural diversity projects.

Summary of progress and main findings

- All required data sets collated, interpreted and reported.
- Engagement across the Avon natural diversity projects including prioritization of on-ground works completed as per agreed schedule.
- A queriable georeferenced database for existing vegetation mapping of the Avon NRM region has been completed. The existing vegetation mapping collated and digitized (this constitutes over 8% of the remnant vegetation the Avon's agricultural area) and the attribution of the digitized vegetation polygons is continuing. These data and the database template are now available to groups working within the Avon and elsewhere.
- Website to publish key findings completed as a beta version, now waiting for the Avon Catchment Council to sign off.
- Providing ongoing support for NatureMap project, which will allow online mapping and download of Avon biodiversity data.
- The current state of monitoring of DRF in the region has been reviewed and a paper (Richardson, J. and Yates, C. (in prep). Twenty years of monitoring threatened flora in Australia's global biodiversity hotspot: Where to now?) in preparation.
- Developing metrics for vegetation condition, rehabilitation objectives and evaluating the success of on-ground vegetation protection activities, this is now one of the RCM Significant Species and Communities case studies.

Management implications

- The DRF monitoring paper makes explicit recommendations for improving DRF monitoring; these recommendations have been submitted through the RCM Significant Species and Communities process.
- The vegetation mapping database is being used to plan corridors and rehabilitation plantings as well as for fire planning.
- The vegetation condition indices project is now one of the RCM Significant Species and Communities case studies.

Future directions (next 12-18 months)

- Complete vegetation mapping database and metrics for condition.
- Working with other groups within the Avon Catchment Council natural diversity group as data support.
- Investigate and perform initial phases toward an online application of Avon vegetation mapping database. Requires collaboration with stakeholders, creation of prototype, workshopping.
- Collaborating with Professor Bob Pressey from James Cook University in developing a strategic conservation plan.
- Managing a contractional arrangement with CSIRO and Murdoch University to improve understanding of the implications of fencing remnant vegetation.
- Finalize Natural Diversity Program website.
- Implement ND customizations in NatureMap.
- Publish important findings.

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.

Baselining the Avon NRM Region (Wetlands)

Team Members

S Jones (1.0), A Pinder (0.1), D Halliday (1.0), A Leung (1.0), C Francis (1.0), P Gioia (0.05).

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.

This project aligns with Corporate priorities 1 and 2 and KRA 2 (NC 2l).

Aim

To map, classify and evaluate the conservation significance of all basin and granite outcrop wetlands greater than 1 hectare, within the Avon NRM region.

Summary of progress and main findings

- Mapping of all basin and granite outcrop wetlands greater than 1 hectare, within the Avon NRM region completed. The dataset is now undergoing final corrections prior to release on NatureMap.
- The Stage 2 framework has been produced and presented to the Wetland Status Working Group, who endorsed it for trial.
- Additional on-ground wetland survey data continues to be collated and attributed to mapped wetlands.

Management implications

The wetland mapping and evaluation dataset will be available to local and State governments. The conservation significance assessments will be used to prioritize areas for wetland conservation. They will also be used to strategically plan drainage activities.

Future directions (next 12-18 months)

- Finalize Stage 2 wetland conservation significance assessments and make this data available on NatureMap.
- Incorporate some strategic catchment planning assessments into the present (Stage 2) framework.
- Finalize the first draft of the Stage 3 wetland classification and evaluation framework, incorporating an improved method for assessing vegetation condition. Then field trial, and using these results, review and improve this framework.
- Present the field results and the final Stage 3 draft to the Wetland Status Working Group for their recommendation of endorsement to the Wetlands Coordinating Committee.
- Prepare a brief report on each wetland surveyed, giving descriptions of their ecological and social value.

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.

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
- Established a Biodiversity Climate Change Unit within the Science Division.
- Initiated and progressed the DEC – South African National Biodiversity Institute (SANBI) science collaboration including scientific exchanges, a colloquium involving Australian and overseas scientists, and three issues papers drafted.
- Developed a biodiversity climate change research framework.
- Initiated climate threshold research projects on germination and water availability.
- Represented Department on Greenhouse IDC, IOCI, State carbon sequestration working group and national NRM climate change working groups.
- Contributed to the development of the National Biodiversity Climate Change Vulnerability Assessment.

Management implications
Climate change is likely to have implications for all aspects of DEC's activities.

Future directions (next 12-18 months)
- Develop and implement a set of research activities to generate the knowledge required to support sound climate change adaptation decisions by DEC.
- Further develop collaborative research activities with scientists at WA's and Australian universities.

- Advise DEC staff about the implementation of Departmental activities and reporting for WA Greenhouse Strategy actions concerned with biodiversity.
- Implement Departmental reporting for the National Climate Change and Biodiversity Action Plan.
- Represent WA in the development and implementation of Australia's national climate change adaptation framework.
- Provide updated climate change data in central information system for policy and planning use.
- Provide climate change–biodiversity information to the public on DEC's website and through other mechanisms.

DEC Regions

Potentially all.

Management of terrestrial bioprospecting in DEC

Core Function.

Team members

R McKellar (0.20), D Coates (0.05); Total (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 analysed 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.
- Paper on factors implicated in the recent decline of Australia's mammal fauna published.
- Paper on Floristic patterns and disturbance history in karri forest published.
- Progressed analysis of FORESTCHECK data for 5-year review.
- Paper on bird responses to silvicultural systems (FORESTCHECK) drafted.
- Paper on biotic responses to silvicultural systems (FORESTCHECK synthesis paper) drafted.
- Statistical review of Woylie decline completed.
- Paper on sampling groundwater fauna submitted.
- Paper on effects of mining on *Tetratheca paynterae* submitted to *Ecological Management and Restoration* (with C Yates and others).
- Paper on Gray and Kingston forest block bird studies submitted to *Conservation Science*.

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.
- Complete FORESTCHECK synthesis paper, once other studies are completed.
- Provide ongoing advice within and outside Science Division as required.

DEC Regions
All.

PERTH OBSERVATORY

Program Leader: Dr James Biggs

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 on Perth Observatory's 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 small solar system 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 three papers in refereed international journals and another 15 in minor publications (almanacs, poster papers, abstracts etc). 100% of referred papers submitted were published (100% in 2007/2008).
- Research activities were given a major boost with a $350 000 capital works allocation in 2006/2007 in order to construct a housing for a 1-m aperture telescope. Lowell Observatory (the USA's largest private astronomical observatory) is the telescope's 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.
- In 2007/2008, $290 000 was allocated for this project. This enabled the basic site preparation to be completed, the construction of a 100-tonne concrete base for the telescope, the trenching and ducting for power and data, the construction of the wall footings, the construction of the floor and construction and erection of the walls and the near completion of engineering design for the dome (roof). It is anticipated that the remainder (about $140,000) of the capital works funding will be used to finish the design, then fabricate and construct dome, and also erect the telescope within the building in 2008/2009.
- Three astronomers based overseas requested time on Perth Observatory telescopes in order to further their research programs. Dr A Kawka of Ondrejov Observatory, Czech Republic, was

granted seven nights to observe the eclipsing binary star ALS1135, Dr D Schleicher from Lowell Observatory, USA, was granted 14 nights to observe Comet 8P/Tuttle, and Professor B Sicardy of the Paris Observatory was granted two nights to observe Pluto – Charon occultations.

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.

Future direction

Text here

Variable star observations

SPP# 1998/009

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), C Mesiku (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

- A program of observing over two dozen central stars of planetary nebulae to discover signs of variability is ongoing. Also, the long-term monitoring of stars TX Pyx, V5558 Sag and SS2883 were scheduled in automatic mode on the PLAT telescope.
- In addition, observations using the PLAT confirmed that V341 Arae is a new nova-like cataclysmic variable star, one of the brightest examples of its class. A paper on this interesting object is in preparation.
- Observations of the unusual O-type eclipsing binary LS 1135 were obtained using the PLAT, in conjunction with researchers from Poland and the Czech Republic. Data is currently being analysed.
- The RAE telescope has also begun photometric observations of the massive binary Eta Carinae. The orbital period is 5.53 years, and the next close approach of the two component stars is due in early 2009.
- The RAE internet telescope is also being used to monitor stars for possible transits by their planets.
- Furthermore, the RAE telescope is being used for a student project that involves a search for faint variable stars in the open star cluster kappa 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# 1998/010

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), C Mesiku (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

Dr D. Schleicher from Lowell Observatory, USA, observed Comet 8P/Tuttle over 14 nights in early 2008. The purpose of these observations were to measure and understand the vaporization rates for the comet as it approaches and recedes from the Sun.

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# 1998/011

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), C Mesiku (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 two student projects that include:
- Monitoring of asteroids and comets with the RAE telescope for regular brightness changes in order to determine their rotation periods.
- 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), C Mesiku (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.

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

This SPP was dormant in 2007/2008 owing to staff shortages.

Future directions

Monitoring of NEOs will continue with the milestone an increased number of published positions.

Monitoring gravitational microlenses

SPP# 1998/013

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), C Mesiku (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 22 full and nine associate members, affiliated with 20 institutions in 10 countries. Access to telescopes in Perth, Siding Springs, Tasmania, South Africa, the Canary Islands, Chile, Brazil, and Hawaii (ranging from 0.6m to 2m) allows 24-hour monitoring during the 'galactic 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, seven 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.

- One refereed paper were published: 'Limits on additional planetary companions to OGLE 2005-BLG-390L', Kubas, D., Cassan, A., plus 39 others including R Martin and A Williams, Astronomy and Astrophysics, volume 483, page 317 (2008)
- Also, an invited review article (non-refereed) was published in 'The Messenger', the journal of the European Southern Observatory (ESO). "Hunting for Frozen Super-Earths via Microlensing', Beaulieu, J.-P., Albrow, M., and 39 others including R Martin and A Williams, The Messenger, volume 128, page 33 (2007)

Future directions

- Several more papers are in preparation.
- The May-September 2008 ‘bulge season’ observing is underway.
- Software to focus the telescope automatically is being developed and this should result in a large improvement in the data quality and number of useful images taken.

Supernova search

SPP# 1998/014

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), C Mesiku (0.03); Total (0.67).

Context

This SPP involves a long-term study of supernovae - an endpoint in stellar evolution. 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.

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.

Summary of progress and main findings

- One supernova, SN2008cn in the galaxy NGC4603, was discovered in the supernova search program. This is an important discovery because a candidate progenitor star has been identified in previous observations of the host galaxy. Measurements of the supernova’s change in brightness are being also acquired.
- Computer software was developed and implemented in order allow the PLAT to observe Gamma Ray Bursts (GRBs). The GRB search is being conducted in collaboration with radio astronomers at Curtin University.
- Research continued concerning supernova SN2004s, and a poster paper concerning this event will be presented at the Astronomical Society of Australia conference in July.
- Development of the computer code to automatically focus the telescope continued.

Future directions

- A scientific paper on SN2004S will be submitted for publication.
- The number of galaxies on the search list will be increased, in particular nearby galaxies and galaxies in the Zone of Avoidance.
- Software to focus the telescope automatically is being developed and this should result in a large improvement in the data quality and number of useful images taken.

Astronomical evaluation of sites in WA

SPP# 2000/006

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), C Mesiku (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 acquired from Mt Singleton during a Landscope expedition in May 2007 were partially analysed.

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: *M Williams*

Project title
Conservation and ecology of Western Australian butterflies

Progress report
The field work component of the three main projects in this study, namely (i) a methodological study to determine optimum sampling strategies; (ii) mark-recapture studies of two 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 three 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 two 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 (three fire regimes x three landscape types: forest ridge, forest slope or swamp heaths x two 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 three monthly to April 2008. To date 14 212 arthropod specimens have been sorted of which 20.2% are beetle species (258 spp.) 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 three monthly samples indicates that beetle biodiversity may be correlated with post-fire litter recovery and patchiness. Sorting, to date has distinguished 154 beetle morphospecies collected from mosaic burnt forest in comparison to 89 beetle morphospecies from wildfire burnt forest for the same sample dates.

Scientist: **D Algar**
Student: *S Hilmer*

Project title
Ecophysiology of the feral cat (*Felis catus*) in Western Australia

Progress report
Cats are common in a variety of habitats, even in harshest environments without access to free water, and appear to be highly adaptive to a wide range of conditions. Despite their abundance and threat to biodiversity, little data is available regarding the cat's ecophysiology.

This study seeks to provide a physiological background and understanding of the ecology of the feral cat by investigating potential differences in Basal metabolic rate and Body temperature regulation of cat populations in relation to different climates (arid, temperate and tropical zone) and seasonal conditions. Furthermore, this study compares physiological differences of free ranging versus captive cats to identify any `captivity effects` that proved to affect the physiology of cats.

Field work for this PhD thesis is nearing completion and the student is expected to complete the write-up mid year 2009. A number of papers are currently being drafted and presentation of certain aspects of the work is to be undertaken at two international conferences later this year.

Scientist: **D Algar**
Student: *K Koch*

Project title
Impact of invasive species on endemic fauna in Western Australia

Progress report
The efficiency of a long term controlling program and the evaluation of the impact of feral cats (*Felis catus*) and foxes (*Vulpes vulpes*) was investigated in a two study sites 400 km distant from Perth, Western Australia. The treatment site was aerially baited with Eradicat baits in winter 2006 and 2007. Fauna surevys were conducted prior to baiting and in spring each year at the treatment site Mt Gibson Sanctuary (baited) and the control site Karara-Lochada pastoral lease (unbaited) to estimate overall population differences and development after start of the control program. Temporal differences were apparent in fauna numbers based mainly on ecological factors. However species richness depended strongly on predator presence. Native species were more vulnerable to predation by cats and foxes than introduced mammal species such as house mouse (*Mus musculus*) and rabbits (*Oryctolagus cunniculus*). Prey selection of cats and foxes is not only related

to prey availability or biomass but also due to biological factors, which increases predation sensitivity of native species, such as predator naivety, different movement patterns, reproduction potential, torpor and diet.

Field work for this thesis has been completed and the student is currently finalizing the write-up. Completion date is the end of July 2008.

Scientist: **AH Burbidge**
Student: *E Fox*

Project title
Call-independent identification in birds

Progress report
The project is now completed, with the thesis being submitted and accepted in early 2008. This thesis demonstrates the application of speaker recognition technology to enable call-independent identification in birds. Call-independence is a pre-requisite for the successful application of acoustic individual identification in many species, especially passerines, but has so far received no attention in the scientific literature. This thesis demonstrates that call-independent identification using neural networks is possible in birds, as well as testing and finding methods to overcome the practical limitations of the methods, enabling their future use in biological studies, particularly for the conservation of threatened species.

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. Ecophysiological assessment of Wandoo shows that it suffers greater water stress than other co-occurring species, jarrah and marri, There was little geographical pattern to water stress response and no correlation with rainfall gradients. 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 were determined both within and between subspecies. Diagnostic microsatellite markers have been developed that enable samples to be identified to subspecies as morphological identification can be difficult.. Four journal papers have been published or submitted:

- Millar M.A., Byrne M., Nuberg I. and Sedgley M. (2008) A rapid PCR based diagnostic test for the identification of subspecies of *Acacia saligna*. Tree Genetics and Genomes in press
- Millar M.A., Byrne M., Nuberg I. And Sedgley M. (2008) High outcrossing and random pollen dispersal in a planted stand of *Acacia saligna* subsp. *saligna* revealed by paternity analysis using microsatellites. Tree Genetics and Genomes 4: 367-377.
- Millar M.A. and Byrne M. (2007) Characterization of polymorphic microsatellite DNA markers for *Acacia saligna* (Labill.) H.L. Wendl. (Mimosaceae). Molecular Ecology Notes 7- 1372-1374.
- Millar M.A., Byrne M., Nuberg I. and Sedgley M. (2008) Long distance inter-subspecific gene flow detected by paternity analysis in remnant *Acacia saligna* (Mimosaceae). Heredity in review.

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 analysed.

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 diversity was high among families but was correlated with longitude. Seedling survival from crosses was positively correlated with genetic distance between parents

trees. Further analysis of the genetic effects on salt tolerance and water logging in these crosses are being carried out.

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 was low despite having both Indian and Timorese germplasm collections. The biosynthetic pathway of sesquiterpene biosynthesis in sandalwood has been investigated and gene sequences from the pathway have been identified. Two journal papers have been published or submitted:

- Jones C.G., Plummer J.A., Barbour E.L. and, Byrne M. (2008) Genetic diversity of the Australian Santalum album collection – tree improvement potential and biogeographic considerations. Tree Genetics and Genomes in review.
- Jones C.G., Keeling C.I., Ghisalberti E.L., Barbour E.L., Plummer J.A. and Bohlmann J. (2008) Isolation of cDNAs and functional characterization of two multi-product TPS enzymes from sandalwood, Santalum album L. Archives of Biochemistry and Biophysics in press.

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 two 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 hybridization between C. tenax and other species.

An enrichment library was made and used to design primers to amplify *Cullen* microsatellite loci. Primers were tested for consistency of amplification and polymorphism within *C. australasicum* and *C. tenax* populations. Additional primers are being tested. The microsatellite loci will be used to genotype field plot plants and their progeny to estimate rates of outcrossing in *C. australasicum* as well as rates of hybridization between *C. australasicum* and *C. cinereum*, *C. discolor*, *C. pallidum* and *C. patens*. Molecular phylogenetic relationships between these species will also be examined.

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

Sixty-seven translocated western ringtail possums (WRPs) and one recruit were monitored by radio-telemetry from April 2006 to March 2008. Regular monitoring of survival, home range, habitat use and health was carried out. Similar proportions of translocated animals died at each site from a variety of causes, including predation by cats, foxes, pythons and raptors. Python predation has been significant at both Leschenault Peninsula and Martin's Tank; raptor predation was more common at Preston Beach Rd than at the other sites. Death was attributed to poor body condition / hypothermia in a small proportion of cases. Possums that dispersed most widely following release were the least likely to survive. Widest dispersal occurred in summer, related perhaps to drought-related foliage quality or to competition with previously translocated animals.

All translocated ringtail possums were health-screened prior to release, and again whenever recaptured for collar renewal. A number of common brushtail possums, resident at the translocation sites, were also health-screened and radio-collared. No differences in disease status have been observed between the two possum species.

Scientist: **P de Tores**

Student: *Helen McCutcheon*

Project title

Possum ecology and health on the Geographe Coastal Plain

Progress report

The project examines naturally occurring populations of ngwayir (Western Ringtail Possum, *Pseudocheirus occidentalis*) and koomal (Common Brushtail Possum, *Trichosurus vulpecula*) at two discrete sites on the southern Swan coastal plain between Bunbury and Busselton.

Preliminary calculation of home range areas and mapping of spatial orientation of home ranges have been completed. Some of the results are likely to significantly advance understanding of home range in both species. Subject to continued funding, this monitoring will be extended to include the period post pine harvesting at Ludlow.

Results of health testing and disease screening have not yet been fully analysed. Preliminary interpretation suggests few significant abnormalities in the physiological profile, and the infectious disease results returned so far are all negative. In the case of leptospirosis, regional seronegativity may be an unexpected and significant finding.

Scientist: **P de Tores**
Student: *Gillian Bryant*

Project title
The ecology and thermal biology of the south west carpet python *Morelia spilota imbricata* in fox-controlled and uncontrolled areas of the swan coastal plain and northern jarrah forest of Western Australia

Progress report
This research has involved surgically implanting 55 pythons (10 prior to G Bryant) with radio transmitters (Holohil®) designed specifically for use in snakes. Twenty three pythons are currently being monitored via radiotelemetry in coastal woodland in both fox-controlled and uncontrolled areas and fox-controlled jarrah forest in the south west of Western Australia. A wealth of data has been collected regarding the individual's ecology including microhabitat, use of landscape (home range), diet, body weight and reproductive condition. Thermal biology data of a number of pythons is being collected with the use of temperature loggers (iButtons® and HOBOs®) recording hourly body and ambient temperature. Haematological characteristics of the pythons are being collected and analysed, and should provide important information to the scientific community on this particular sub species of carpet python. This research will be completed by mid-2009.

Scientist: **P de Tores**
Student: *Jennyffer 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
Effective management of prey species in the northern jarrah forest requires knowledge not only of the effects of fox and cat predation on prey populations, but also on how predation interacts with other extrinsic factors to limit populations.

Trapping at nine sites has yielded three sites with good possum abundance, three sites with very low abundance and no possums on the remaining three sites. Seasonal trapping has continued at seven of these sites to collect information on survival, body condition, reproductive output, offspring sex-ratio and abundance as well as scats for diet analysis.

15 possums are currently being radio-collared at three sites to monitor their survival and to obtain home-range data and determine the number of dens used at each site.

Scientist: **P de Tores**
Student: *Tracey Moore*

Project title

Western ringtail possum, *Pseudocheirus occidentalis*: preference for nest boxes and nest box use after translocation

Progress report

Three nest boxes were designed after consultation with a range of wildlife carers involved with *P. occidentalis*. The preference for use of these designs for captive possums was determined by direct observation. Preference was inferred for possums released at translocation sites by data collected from iButton®, (temperature data loggers), radio telemetry and from hair collected within nest boxes.

The findings concluded *P. occidentalis* will use nest boxes in captivity but appeared to show no preference for any of the three designs available. Upon release, nest boxes were not utilised by the possums. Nest boxes therefore appeared to offer no advantage to translocated western ringtail possums.

Scientist: **P de Tores**

Student: *Anna Nowicki*

Project title

Analysis of capture data: A case study using program MARK for analysis of brushtail possum trapping data and its relevance to conservation management of the western ringtail possum

Progress report

Program MARK, and the information-Theoretic (I-T) approach, was used to obtain estimates of population size for the common brushtail possum at Leschenault Peninsula Conservation Park and Yalgorup National Park in south-west Western Australia. These conservation reserves are release sites for translocated populations of the western ringtail possum, *Pseudocheirus occidentalis*.

Estimates of common brushtail possum population size were derived using the Huggins Closed Capture model type in program MARK. The results from the model selection process support the hypothesis that where predation risk was low (in baited areas), brushtail possums prefer vegetation which provides optimum foraging habitat (open vegetation structure) and where predation risk is higher (unbaited sites), the common brushtail possum will select dense vegetation which provides a predation refuge.

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 two 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 summarized in Tuart Bulletin No. 6 The role of fire in Tuart decline at Yalgorup.

Robert's thesis was accepted in 2007.

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 shelterwood 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.

Seedfall and germination were monitored during winter 2007 following a post-harvest burn conducted in a shelterwood coupe at Amphion block east of Dwellingup in May 2007. Seedfall and germination monitoring have also commenced following shelterwood burns conducted at Dale and Palmer blocks in spring 2007, and Wilga and Helms forest blocks in autumn 2008. Further investigation of seed crop assessment was undertaken over the past summer and included direct inspection of seed crops within intact tree canopies from an elevated work platform.

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 years 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 been developed. Fire occurrence has been examined in relation to vegetation type as mapped at 1:250 000 scale by Dr John Beard, with distinctive patterns defined for woodlands, mallee and sandplain shrublands. A manuscript describing the use of *Callitris preissii* stem sections and cores for dendrochronology has been submitted for publication. Conference papers were delivered at the 2007 Bushfire CRC conference in Hobart, and at the 2007 Ecological Society of Australia conference in Perth.

Scientist: **L McCaw**

Student: *Jennifer Hollis*

Project title

Coarse woody fuel availability and consumption in Australian forest fires

Progress report

The ability to predict the amount and type of fuel consumed during bushfires is important to land and fire managers throughout Australia. Consumption of coarse woody fuels is important for wildlife habitat management and plant regeneration, prediction of radiant heat load on firefighting personnel and equipment, and for carbon accounting. Factors governing the consumption of fine fuels <6 mm diameter are well understood but less is known about the consumption of coarse woody fuel that may smolder for some time following the passage of a flaming fire front.

This project commenced in October 2007. Fuel characteristics were quantified at three sites in jarrah forest, and a sample of woody fuel particles fitted with wires to allow measurement of diameter before and after burning for estimation of consumption. Experimental fires were conducted in spring at Wilga and Quillben forest blocks, and at Hester block in autumn. Weather, fuel moisture and drought conditions were quantified for each fire.

Preliminary data analysis is underway, and potential sites for additional experimental fires in south-eastern Australia are being evaluated.

Scientist: **N McKenzie**

Student: *P Webala*

Project title

Bat community structure and habitat use across disturbance regimes in jarrah forests, South-western Australia.

Progress report

The project consists of two major components. First, investigating bat community responses to jarrah forest logging in south-western Australia. This involves assessing the differential habitat use of foraging and commuting bats (herein referred to as bat activity) in different logging history treatments (logged, regrowth and unlogged sites) by the use of Anabat SD1 Bat Detectors. The second major component involves the study of the roosting and foraging ecology of two bat species, namely; the Southern forest bat *Vespadelus regulus* and Gould's long-eared bat *Nyctophilus gouldi.*

Here captured bats are radio-collared and tracked to their day roosts in order to investigate roost tree, and site, selection. The other components include a description of vegetation structure and assessment of insect abundance in different logging history treatments. Vegetation structure is directly affected by logging operations and in turn affects bat activity. Insect abundance on the other hand has a positive relationship with foraging activity of bats. All these activities were assessed in 2007.

Good progress has been achieved in the both component of the study; assessing bat activity and radiotracking. While the major analyses of data for bat community assemblages on the effects of jarrah forest logging is still underway, preliminary findings show that the activity of bats is unaffected by logging history. However, bat activity is significantly different between on-track and off-track sites at both the community and individual species levels. Consistent with findings in eastern Australia, forest tracks are thus important in ameliorating the impacts of logging on bats in selectively timber-harvested forests and should be maintained for their long-term persistence.

The radiotracking activity is underway with preliminary findings showing that Gould's long-eared bat *Nyctophilus gouldi* roosts in tree hollows, under exfoliating bark and in logs of both jarrah and marri trees. Roost switching was common in individuals faithful to a roost area. Roosts used on successive days were usually within 300 m of each other in the same general area, underscoring the importance of maintaining multiple roosts with a diverse range of hollow-bearing trees, even when these hollows are not being used at the time of logging.

Scientist: **I Radford**
Student: *A Cook*

Project title
Can mosaic burning protect northern quolls from sever wildfires in the north Kimberley?

Progress report
There has been considerable debate about the role of patch mosaic burning as an approach to managing the perceived negative effects of severe fire regimes. Despite the proposition to apply fine-scale fire mosaics, pyrodiversity *per se* (diversity in fire fine-scale mosaics) may not necessarily beget biodiversity. Declining northern Australian CWR mammals, and in particular northern quolls *Dasyurus hallucatus*, provide a useful model to test the hypothesis that patch mosaic burning is beneficial. Northern quolls are in low numbers in much of their present range, apparently due largely to severe and extensive fire regimes, and also to cane toad invasion. In contrast, northern quolls remain abundant in the Mitchell River region of the north Kimberley, where fine-scale fire mosaics and absence of cane toads have apparently allowed the species to flourish. This situation provides an unique opportunity to test the hypothesis that fine scale mosaic burning contributes to population persistence. Detailed comparisons of demography, mortality, fecundity and recruitment will be made between populations in fine-grain mosaics and populations outside this area on the same habitat types. Radio tracking will provide information on causes of mortality, thereby allowing us an insight into mechanisms associated with fire mosaic effects.

This project will test the hypothesis that fine-grained fire mosaics provide better habitat for northern quolls than that provided by coarse-grained mosaics typical of the north Kimberley. Key aspects of quoll populations will be measured to quantify the favorability of habitat:

Population densities, age and size structure, body condition, fecundity, recruitment and mortality territory size,

Fate of individuals – are deaths attributable to cats, dingoes, birds of prey, reptile predators (e.g. snakes, goannas) or starvation/disease?

Resources – do northern quoll populations track resources (prey) abundance?

Field studies will commence in August 2008 to establish monitoring populations and assessment of pouch young inside and outside fine grained fire mosaics through trapping and radio collaring at

Mitchell. A wet season field trip is planned in March 2009 to assess recruitment of juvenile northern quolls and survival of mature individuals

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Scientist: **C Simpson**
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
Luisa has completed her Masters thesis and a copy is held by the Marine Science Program. This study used hyperspectral imagery to map vegetation cover and condition in the Coral Bay area. It has potential use as a baseline dataset for the monitoring of vegetation condition and changes in ground cover in this coastal area. 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. 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: **C Simpson**
Student: *B Fowles*

Project title
Shifting baselines in commercial and recreational fisheries at Ningaloo Marine Park

Progress report
Brooke has completed her Honours, a copy of which is held by the Marine Science Program. This study used physical records and interviews with fishermen to examine fishers' perceptions of what constitutes a 'good catch' and how this has changed over the past four decades. Insight into changes in targeted fish communities over time will assist with management of Ningaloo Marine Park.

Scientist: **C Simpson**
Student: *D Holley*

Project title
Development of dugong (*Dugong dugon*) research capacity through use of innovative tracking technology

Progress report
This project is currently underway with a recent field trip leading to the successful tagging of two dugong in the northwest. The project is developing collaboration with indigenous groups in the Kimberley and has involved the Bardi-Jawi Sea Rangers in the recent field exercise. Further tagging expeditions are planned for later this year.

Scientist: **C Simpson**
Student: *J Neiman*

Project title
Diurnal variability in beach use patterns at Bundegi, Turquoise Bay, and Coral Bay, Ningaloo Marine Park

Progress report

Jody has completed her thesis, a copy of which is held by the Marine Science Program. A science publication is currently in preparation by Jody Neiman and Dr Lynnath Beckley. Her research was also funded through the CSIRO Wealth from Oceans Flagship and will be incorporated into Project 2 of the Ningaloo Collaboration Cluster. This information will assist with planning for minimal impact of visitors to beaches in Ningaloo Marine Park.

Scientist: **M Stukely**

Student: *A Rea*

Project title

Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species

Progress report

It has recently come to light, utilizing molecular tools, that many current and historical isolates of *Phytophthora* from around the southwest of Western Australia which were previously classified as known named species, are actually unnamed taxa. There are now known to be as many as 10 new taxa, the isolates of which are stored by the Vegetation Health Service (VHS) of DEC. These taxa are at present referred to as *Phytophthora* species 1 (Psp1) through to Psp10. This PhD project will characterize Psp1 through to Psp10 from a molecular taxonomic perspective, and Psp1, Psp2, and Psp9 from a classical taxonomic perspective. In addition, the pathogenicity of Psp2 will be assessed on *Eucalyptus marginata* and *Banksia attenuata*, and the pathogenicity of Psp1 and Psp9 will be assessed on *B. attenuata*. A microsatellite analysis of a worldwide population of *P. citricola* will also be undertaken. Psp4 (previously classified as *P. citricola*) will be included in this study.

In June 2008 the project had been running for 14 months. To date, morphological measurements of Psp2 and Psp9 have been completed. Measurements of Psp1 are in progress. Growth tests to determine the cardinal temperatures of Psp2 and Psp9 have been undertaken, with Psp1 now to follow. A pathogenicity trial looking at the effect of Psp2 on *E. marginata* has been established since December 2007, and is still running. Pots (120) containing 4x *B. attenuata* plants each have been set up for a pathogenicity trial assessing the virulence of Psp1, Psp2, and Psp9 on this species. This trial will commence in September and run over summer 2008-09.

Scientist: **S van Leeuwen**

Student: *G Page*

Project title

Mulga ecology and applications to site restoration at West Angelas, Pilbara.

Project report

This project commenced in April 2005 as a Ph.D. research project being undertaken by Gerald Page (supervised by Pauline Grierson, Louise Cullen and Stephen van Leeuwen), with the broad aim to investigate the structural and ecophysiological diversity of *Acacia aneura* (mulga) and its close relatives across the range of landscapes and soil types present at West Angelas,aniron ore mine in the Pilbara. The PhD candidate has recently completed a field experiment looking at the ecophysiological response of mulga to a simulated late cyclonic rainfall event. We also have an ongoing collaboration with the Understanding Mulga project (DEC) to determine the genetic similarity of the mulga 'types' identified during the study in the West Angelas area.

Manuscript development for publication is ongoing, and the thesis will be submitted in April 2009.

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

- Species categorized into functional groups
- Pollinator communities and reproductive biology attributes measured for taxa in each functional group across range of population sizes and contexts
- Presented findings at Australian Network for Plant Conservation Conference 2008
- Thesis writing in progress.

Scientist: **C Yates**

Student: *K Maher*

Project title

Encroachment of sandplain heathland (kwongan) by *Allocasuarina huegeliana* in the Western Australian wheatbelt: the role of herbivores, fire and other factors.

The aims of the project are to describe:

- The extent of *A. huegeliana* encroachment in kwongan in remnant vegetation in the Western Australian wheatbelt and whether it is likely to be a long-term problem?
- Which environmental factors affect *A. huegeliana* establishment in kwongan during inter-fire periods?
- How native mammal browsing affects *A. huegeliana* establishment in the inter-fire and immediate post-fire periods?
- What are the likely outcomes of long inter-fire periods in remnants where native herbivores are largely absent?

Progress report

Thesis has been completed and PhD awarded. Fire management in wheatbelt reserves is discussed.

Scientist: **C Yates**

Student: *A Nield*

Project title

The conservation biology of the Critically Endangered plant *Calytrix breviseta* ssp. *breviseta*

The aims of the project are to:

- Undertake population viability analysis (PVA) to assess the impacts of various threats (including fire, fragmentation and weed invasion) on the long term viability of the only known population of *C. breviseta* ssp. *breviseta*.
- Examine the impacts of various threats (fire and weeds) on the composition and dynamics of the floristic assemblage associated with *C. breviseta* ssp. *breviseta.*

Progress report

Demographic and composition of floristic assemblage data have been collected for the *C. breviseta* ssp. *breviseta* following two successive fires in 1994 and 2007.
