Department of Environment and Conservation

# Science Division annual research activity report

## and management implications

## 2008 – 2009




Department of
Environment and Conservation

*Our environment, our future*

# DIRECTOR'S MESSAGE

The Department of Environment and Conservation's (DEC's) policies and operations need to be underpinned by the incorporation of up-to-date knowledge. The Science Division is DEC's prime source of new conservation biology knowledge and information based on scientific research. With about 166 scientific, technical and administration staff, (excluding Perth Observatory staff) the division is the largest and most scientifically diverse group of conservation scientists in Western Australia. The Perth Observatory (10 staff), a program within the Science Division, focuses on delivering astronomy services in the areas of research, information and education.

The conservation and land management work of the division reflects a significant investment by the State Government, through DEC, in multi-disciplinary biodiversity conservation research, monitoring and biological survey, and this year we formed the Biodiversity and Climate Change Unit (see page 59) to address an important emerging issue.

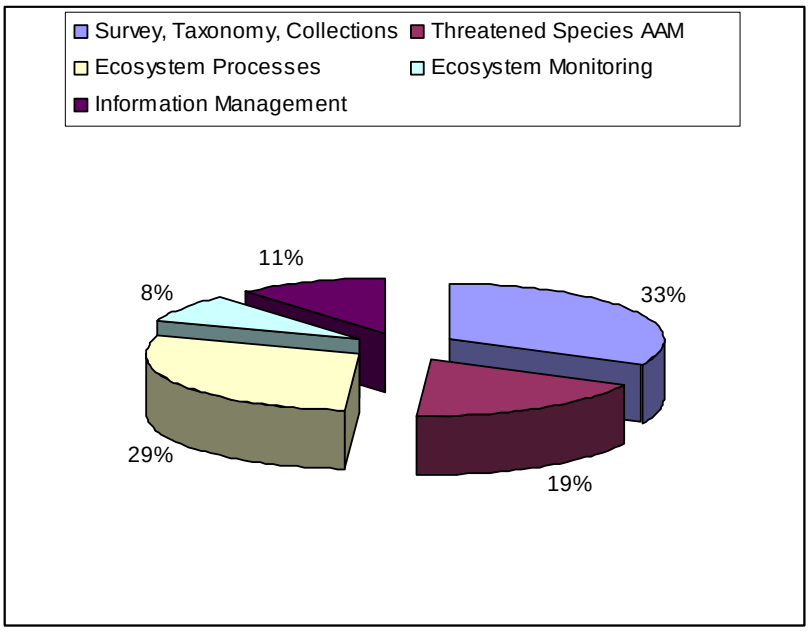
**Science, operational research and active adaptive management**

The Science Division carries out activities that deliver on-ground conservation and land management outcomes as well as generating new knowledge. The pie chart below shows that ~33% of the division's staff time (F.T.Es) is committed to biological survey, taxonomy and plant collections management. These activities are fundamental to the mission of a conservation and land management agency such as DEC – if we don't know what we have, where it is, why it is where it is and what condition it's in, we can't begin to manage it. A further 29% of staff time is committed to understanding landscape-scale ecosystem processes such as fire, introduced/feral animals/plants, altered hydrology, genetics, climate change, pests and diseases and timber harvesting. DEC invests in this research in order to develop credible, safe and cost effective methods for managing threats to the state's unique biodiversity.

Theatened species work, which accounts for ~19% of staff time, is mostly carried out in an active adaptive management (AAM) framework - a systematic process of modelling, operational-scale experimentation, monitoring and reporting – or learning by doing. In fact most of the Science Project Plans (SPPs) reported here are AAM plans. These projects not only advance an understanding of the ecology and biology of threatened species, but they actually improve their conservation status. For example, research on Gilbert's potoroo over the last 3-4 years has not only advanced our understanding of the species' biology, but has resulted in an almost doubling of the population of the world's rarest marsupial. Because these programs are implemented in an AAM framework, we are able to understand cause-and-effect pathways and measure, document and report on the effectiveness of our actions to improve the conservation status of threatened taxa.

About 8% of divisional staff time is committed to monitoring ecosystem process and reporting on resource condition. This includes monitoring associated with timber harvesting, salinity and altered hydrology, fire and natural variation, and about 11% of staff time is committed to information management including Florabase, Naturemap, marine and terrestrial baselining projects and database management. The division generates a substantial amount of information each year and we need to continue to improve our ability to manage and add value to this information if it is to be efficiently utilised.

Associated with the activities reported here, Science Division staff spend a significant amount of time (~30% on average) providing policy, planning and general advice, participating on committees, on technology transfer and uptake and on other science extension activities within and external to DEC.




*A breakdown of Science Division staff time (% F.T.Es) allocated to five broad themes important to delivering conservation and land management outcomes. This includes a proportional allocation of administration and library support staff time. Ecosystem Processes/Monitoring includes; fire, feral/introduced plants/animals, salinity/altered hydrology, climate change, pests and diseases and timber harvesting. Information management includes; Florabase, Naturemap, marine and terrestrial baselining projects and other database management. AAM = active adaptive management. In addition, ~5% of divisional F.T.Es are engaged in astronomy research, education and information.*

**Communicating science**

Communicating what we do and what we have discovered is crucial to making a difference and for the on-going support of those who invest in research and who use science-based knowledge as a basis for decision making and on-ground management. As scientists we need to be good communicators for at least the following reasons:

- Institutional: We have an obligation to the department, the government and the broader Western Australian community to generate and communicate new knowledge and information; it's primarily what we are funded to do. Policies, procedures and prescriptions supported by good science and an informed community, enable DEC to do its job well and give politicians and the broader community confidence in us. Political and community support for the department and for science is crucial if we are to be successful.

- Professional: As a scientist, it is a professional obligation to communicate new findings to other scientists, fellow workers and key stakeholders. It is also an important part of the process of critical peer review of what we, both as an agency and as individuals, produce.

- Recognition: Through awareness, scientific research can be properly valued both by colleagues and staff in the department and by those who influence its funding. The role of science in shaping policies and practices needs to be made immediately apparent if it is to be appreciated. We must actively promote the good work we do and the important role it plays in underpinning biodiversity conservation and natural resource management in Western Australia.

- Personal: A scientist's reputation (and that of scientific institutions) is largely built on the quality and quantity of published work and the impact of this work. Personal rewards (beyond salary and career) include a sense of pride and achievement, recognition and respect by peers, job satisfaction and a greater likelihood of ongoing management support.

Communicating to politicians, practitioners, planners and other decision makers, as well as colleagues and the broader community requires a range of communication techniques. Important information needs to be communicated to the right people using appropriate means – one size does not fit all.

The Science Division has developed a plan that sets out ways to communicate the work of the division to a diversity of audiences. The plan recognises three main audience groups – the science community, influential stakeholders (other than the science community) and the general public – each further sub-divided into several sectors.

The science community is primarily comprised of our peers and colleagues in tertiary (and other) organisations and collaborative research agencies such as CSIRO, and our fellow scientists in DEC. Influential stakeholders include but are not limited to senior State Government scientific staff, WA's Chief Scientist, scientific political advisors, funding agencies, funding decision-makers (internal and external), politicians, DEC staff in other divisions, local governments and representatives from the private sector. The general public includes the general community, media representatives, opponents, proponents, students, educators, environmental groups, community action groups, volunteers, Indigenous people and others.

Communicating to these people/groups requires a variety of methods – including scientific publications (e.g. peer reviewed papers etc.), conferences, workshops, media coverage, internet, reports, articles in conservation publications, professional liaison, meetings, newsletters, brochures, educational packages, advertising, interpretive displays, open/field days and detailed briefings. It involves telling the story and getting the message across in different ways; at a high level, a low level, to small organisations, to large ones, to other departments, to the general public, to the media, to local communities, to the young and the old.

The World Wide Web via the Internet has become by far the most powerful and far reaching communication tool. The Science Division will make a concerted effort to increase internet presence over the next two years. For example, the award winning NatureMap, compiled in collaboration with the WA Museum, is an ideal platform for making information about the State's biota readily available. Another recent communication initiative that has proven to be very popular within DEC, and externally, is the new series of 'Science Information Sheets' that are posted on our internet site at:

http://www.dec.wa.gov.au/science-and-research/publications-and-resources/factsheets-posters.html

With regard to written products, it is pleasing to note a significant increase in output over the period 2008/09. This report (page 11) lists 431 publications, popular articles and unpublished reports across a diversity of topics and disciplines. The division also publishes two journals, Conservation Science WA and Nuytsia. One issue of Conservation Science WA was published this year with 206 pages, and two issues of Nuytsia were published, with 546 pages of plant taxonomy research.

The division continues to invest in maintaining a quality Departmental library, with three collections – at the Kensington and Woodvale Research Centres and at the DEC Perth Herbarium. About 50% of DEC library users are Science Division staff and the remainder are staff from other Divisions. Currently, the Library Catalogue has 159 113 records:

- 33 427 book/report titles
- 1 783 journal/newsletter titles (453 current)
- 12 809 monographic journals
- 27 704 reprints
- 69 763 indexed journal articles and book chapters
- 3 406 pamphlets
- 3 026 links to online resources

- 7195 PDFs linked to catalogue records

There are also 12 687 records in the on-line bibliography of Science Division publications which can be accessed at http://science.dec.wa.gov.au/papers/

The Science Division continues to be active across DEC's administrative regions and the state's IBRA's and IMCRA's (see below). Scientists appointed as Regional Liaison Officers maintain links with the various DEC regions and branches to ensure good flow of information between the groups.

| DEC Region * | No. Projects | IBRA ** | No. Projects | IBRA | No. Projects | IMCRA *** | No. Projects | IMCRA *** | No. Projects |
|---|---|---|---|---|---|---|---|---|---|
| Warren | 73 | Avon Wheatbelt | 55 | Jarrah forest | 77 | Central West Coast | 9 | Leeuwin-Naturaliste | 5 |
| Swan | 66 | Carnarvon | 24 | Little Sandy Desert | 21 | Abrolhos Islands | 5 | Ningaloo | 12 |
| South West | 65 | Central Ranges | 22 | Mallee | 41 | Bonaparte Gulf | 5 | North West Shelf | 6 |
| Midwest | 64 | Central Kimberley | 22 | Murchison | 29 | Canning | 5 | Oceanic Shoals | 7 |
| Wheatbelt | 62 | Coolgardie | 34 | Northern Kimberley | 25 | Eighty Mile Beach | 5 | Pilbara Nearshore | 7 |
| South Coast | 60 | Dampierland | 23 | Nullarbor | 22 | Eucla | 5 | Pilbara Offshore | 7 |
| Pilbara | 48 | Esperance Plains | 51 | Ord Victoria Plain | 21 | Kimberley | 5 | Shark Bay | 7 |
| Goldfields | 45 | Gascoyne | 26 | Pilbara | 26 | King Sound | 5 | WA South Coast | 6 |
| Kimberley | 40 | Geraldton Sandplains | 43 | Swan Coastal Plain | 52 | | | Zuytdorp | 5 |
| | | Gibson Desert | 21 | Tanami | 20 | | | | |
| | | Great Sandy Desert | 20 | Victoria Bonaparte | 23 | | | | |
| | | Great Victoria Desert | 22 | Warren | 53 | | | | |
| | | Hampton | 20 | Yalgoo | 28 | | | | |

*27 of these projects were relevant to all DEC regions

**18 of these projects were relevant to all IBRAs (Interim Biogeographic Regionalisation of Australia)

***17of these projects were relevant to all IMCRAs (Integrated Marine & Coastal Regionalisation of Australia)

Dr Neil Burrows
Director Science Division
July 2009

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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.

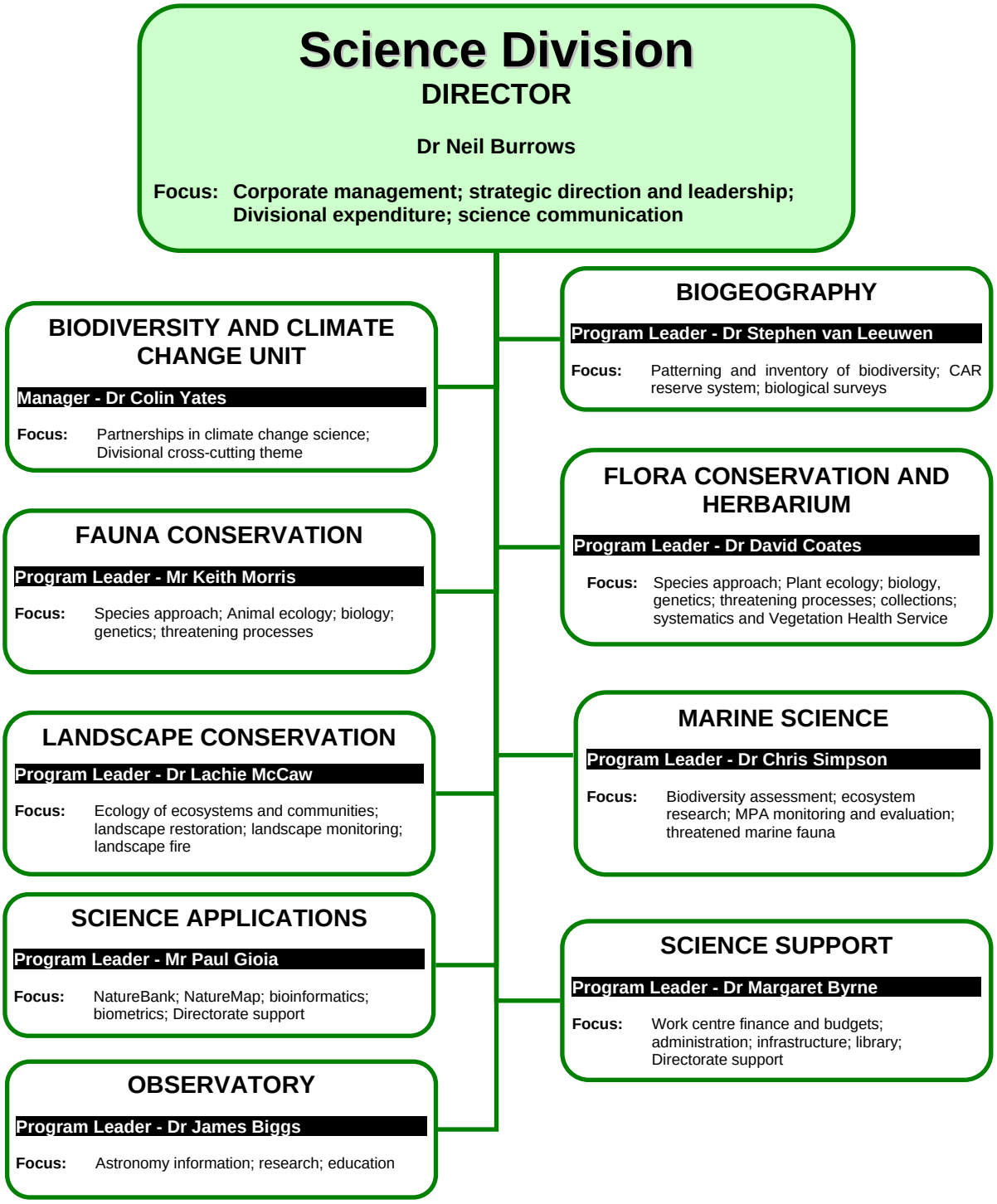
# FOCUS AND PURPOSE

Provision of up-to-date and scientifically sound information to uphold effective conservation of biodiversity and sustainable natural resource management in Western Australia. We strive to provide excellence in science and technology based on internationally recognised best practice. We operate research centres that foster, promote and reward creativity and innovation.

# ROLE

- 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 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 on sustainable resource development opportunities and to promote the conservation of biological resources through their sustainable utilisation;
- To communicate and transfer to managers in DEC, 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;
- 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; and
- To undertake and participate in astronomy research, information and education for the benefit of local, national and international communities.

# SERVICE DELIVERY STRUCTURE



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422. Wilson PG (2008) *Coronidium*, a new Australian genus in the Gnaphalieae (Asteraceae). *Nuytsia* **18**, 295-329.
423. Wilson PG (2008) A new subspecies of *Gnaphalium indutum* (Asteraceae: Gnaphalieae). *Nuytsia* **18**, 291-293.
424. Wilson PG (2008) Notes on the genus *Chrysocephalum* (Angianthinae: Asteraceae) with the description of one new species from Western Australia and a new combination. *Nuytsia* **18**, 331-338.
425. Wilson S (2009) Climate change and coral reef habitat: implications for fish. *In: A Changing Climate, Western Australia in Focus: Presenters' Abstract Papers: Symposium, 27 March 2009, the University Club of Western Australia, Crawley, Perth, Western Australia, Australia.* pp. 27-28. Western Australian Marine Science Institution, Perth.
426. Wittkuhn RS, Hamilton T, McCaw L (2009) Fire interval sequences to aid in site selection for biodiversity studies: mapping the fire regime. *Proceedings of the Royal Society of Queensland* **115**, 101-111.
427. Wittkuhn R, McCaw L, Phelan G, Farr J, Liddelow G, van Heurck P *et al.* [Wills A, Robinson R, Cranfield R, Fielder J, Dornan C] (2009) Assessing the effects of contrasting fire intervals on biodiversity at a landscape scale. In: *Fire, Environment and Society: From Research into Practice, Adelaide Convention Centre, 1-3 September 2008: the International Bushfire Research Conference Incorporating the 15th AFAC Conference: Conference Papers* Bushfire CRC, Melbourne. 482-493 p.
428. Wittkuhn R, McCaw L, Roberts P (2008) Can ecological research address socio-political factors in fire management planning? A case study in Western Australia (POSTER). In: *Fire, Environment and Society: From Research into Practice, Adelaide Convention Centre, 1-3 September 2008: the International Bushfire Research Conference Incorporating the 15th AFAC Conference: Conference Papers* p. 521. Bushfire CRC, Melbourne.
429. Woolford L, O'Hara AJ, Bennett MD, Slaven M, Swan R, Friend JA *et al.*

[Sims C, Hill S] (2008) Cutaneous papillomatosis and carcinomatosis in the western barred bandicoot (*Perameles bougainville*). *Veterinary Pathology* **45**, 95-103.

430. Wright L, Harding D (2008) Western Australia Department of Environment and Conservation, Library and Information Services. In: *ALIES 2008 Conference: ALIES 3.0: Information Catalysts* p. 1. Conference Planning Committee, Mount Macedon.

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## PUBLICATIONS AND REPORTS OMITTED FROM THE 2007-2008 ANNUAL RESEARCH ACTIVITY REPORT

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2. Biggs JD (ed) (2007) Western Australian astronomy almanac 2008. Perth Observatory, Bickley. 120 p.
3. Bougher N, Hart R, de Bueger S, Glossop B (2007) Perth Urban Bushland Fungi Project, September 2007. *Fungimap Newsletter* 33, p. 11.
4. Cochrane A, Daws MI (2007) (No) Temperature limits to recruitment in montane SW Australian narrow range endemics (ABSTRACT). In: *Seed Ecology II: the 2nd International Society for Seed Science Meeting on Seeds and the Environment, Perth, Western Australia, Sunday 9-Thursday 13 September 2007: conference proceedings* (eds S Turner, D Merritt, S Clarke *et al.*), p. 1. Conference Organising Committee, Perth.
5. Cochrane A, Monks L, Lally T (2007) Response of the germinable soil-stored seed bank of a remnant reserve in the southern Western Australian agricultural zone to smoke and fire treatment. *Journal of the Royal Society of Western Australia* 90, 47-52.
6. Cohen M, Parker QA, Green AJ, Murphy T, Miszalski B, Frew DJ *et al.* (2007) Spitzer IRAC observations of newly-discovered planetary nebulae from the Macquarie-AAO-Strasbourg H[alpha] Planetary Nebula Project. *Astrophysical Journal* 669, 343-362.
7. Dalmaris E, Poot P, Byrne M, Veneklaas E (2007) Wandoo decline: an ecophysiological and phylogeographical analysis. In: MedEcos XI: conference proceedings: the International Mediterranean Ecosystems Conference, Perth, Western Australia, Australia, Sunday 2-Wednesday 5 September 2007 (eds D Rokich, G Wardell-Johnson, C Yates *et al.*), pp. 57-58. Kings Park & Botanic Garden, West Perth.
8. De Tores P, Marlow N, Algar D, Morris K, Glen A, Sutherland D *et al.* [Cruz J, Bryant G] (2007) Mesopredator release: a response to 1080 control of foxes in WA: what is the evidence and what are we doing (POSTER ABSTRACT). In: *ESA 2007, Program and Abstracts: Perth Convention and Exhibition Centre, Perth, Australia, 2007, Monday 26th November to Friday 30th November 2007* p. 186. Conference Organising Committee, Perth.
9. Friend T (2007) Rescuing Gilbert's potoroo: the world's most endangered marsupial, with community help. In: Proceedings of the Fifth Annual National Wildlife Rehabilitation Conference: Perth, Western Australia, 6-9 August 2007 218-223.
10. Hetherington CA, Algar D, Mills H, Bencini R (2007) Increasing the target-specificity of Eradicat® for feral cat (*Felis catus*) control by encapsulating a toxicant. *Wildlife Research* 34, 467-471.
11. Hopkins A (contrib) (2007) Oceania. In: The World's Mangroves 1980-2005: a Thematic Study Prepared in the Framework of the Global Forest Resources Assessment 2005 pp. 37-42.

FAO, Rome.

12. Huisman J, Millar A (2007) The Liagoraceae (Rhodophyta) of New Caledonia collected by Vieillard, including Ganonema filicoides (Kützing) comb. Nov. *Cryptogamie Algologie* 28, 201-207.
13. Leliaert F, Huisman J, Coppejans E (2007) Phylogenetic position of Boodlea vanbosseae (Siphonocladales: Chlorophyta). *Cryptogamie Algologie* 28, 337-351.
14. Lierich D, Bancroft K (2007) Bibliography of marine scientific research relevant to Perth's metropolitan marine protected areas and adjacent waters. Department of Environment and Conservation, Western Australia, Marine Science Program, Data Report CWC//MMP,SEMP,SIMP 2007/06, Department of Environment and Conservation, Kensington, WA. 66 p.
15. Lierich D, Bancroft K (2007) Current and proposed marine research relevant to Perth's metropolitan marine protected areas and adjacent waters. Department of Environment and Conservation, Western Australia, Marine Science Program, Data Report CWC//MMP,SEMP,SIMP 2007/07, Department of Environment and Conservation, Kensington, WA. 18 p.
16. Long S (2007) Disturbance and recovery of coral communities in Bills Bay, Ningaloo Marine Park: field survey, 16-23 October 2006. Department of Environment and Conservation, Western Australia, Marine Science Program, Technical and Data Report MSP-2007/05, Department of Environment and Conservation, Kensington, WA. 69 p.
17. Moody ML, Les DH (2007) Phylogenetic systematics and character evolution in the angiosperm family Haloragaceae. *American Journal of Botany* 94, 2005-2025.
18. Morris K, Orell P, Cowan M, Broun G (2007) Reconstructing the mammal fauna of Lorna Glen in the rangelands of Western Australia, 2008-2016. Department of Environment and Conservation, Woodvale, WA. 11 p.
19. Morris K, Thomas N, Johnson B, Orell P, Brennan K (2007) A report on the selection of release sites for bilbies (*Macrotis lagotis*) and brushtail possums (*Trichosurus vulpecula*) at Lorna Glen. Department of Environment and Conservation, Woodvale, WA. 6 p.
20. Prober SM, Thiele KR, Bramwell M (2007) Intense fires promote uncommon post-fire ephemerals in currawang, Acacia doratoxylon, dry scrubs of Little River Gorge, east Gippsland. *Victorian Naturalist* 124, 320-331.
21. Richardson J, Stanley FJ, Kendrick PG, Kregor G (2007) The flora and fauna of Legendre Island. *Conservation Science Western Australia* 6(1), 97-108.
22. Robinson R (2007) Curious caps. *Fungimap Newsletter* 32, 4-5.
23. Robinson R (2007) First Fungimap record of *Cordyceps gunnii* in Western Australia. *Fungimap Newsletter* 33, 4, 8.
24. Smith PP, Trivedi C, Cochrane A, Crawford A, Way M (2007) The Millennium Seed Bank Project delivering Target 8 of the Global Strategy for Plant Conservation. *BGJournal* 4(2), 9-12.
25. Stukely MJC, Webster JL, Ciampini JA, Brown E, Dunstan WA, Hardy GE St J, Woodman GJ, Davison EM, Tay FCS (2007) *Phytophthora inundata* from native vegetation in Western Australia. *Australasian Plant Pathology* 36, 606-608.
26. Sutherland DR (2007) Introduced predator management and its impact on varanid lizards (ABSTRACT). In: *33rd Meeting of the Australian Society of Herpetologists: 4th to 7th December, 2007, Camp Quaranup, Albany, Western Australia* p. 54. Conference Organising Committee, Albany.
27. Tovar FJ, Burgess T, Robinson RM, Hardy GE (2007) Survey of fungi on Eucalyptus globulus coppice stumps in Western Australia (ABSTRACT). In: Root and Butt Rots of Forest Trees: 12th International Conference on Root and Butt Rots: 12th-19th August 2007, Berkeley, California; Medford, Oregon: Program and Abstracts p. 38. IUFRO Working Party 7.02.01, Berkeley.
28. Tovar FJ, Robinson RM, Burgess T, Hardy GE (2007) An investigation on the effect of the season of harvest on fungal colonisation of living *Eucalyptus globulus* coppice stumps (ABSTRACT). In: *Root and Butt Rots of Forest Trees: 12th International Conference on Root and Butt Rots: 12th-19th August 2007, Berkeley, California; Medford, Oregon: Program and Abstracts* p. 49. IUFRO Working Party 7.02.01, Berkeley.
29. Van Heurck P, Manning J, Steele C,

Middleton E, Muir G, Rinnhofer K (2007) Nuyts Wilderness beetles & fire (ABSTRACT). In: The Combined 8th Invertebrate Biodiversity & Conservation Conference 2007: Program and Abstracts: Queensland Museum, 2 -7 December 2007, Brisbane p. 1. Conference Organising Committee, Brisbane.

30. Van Heurck P, Manning J, Steele C, Middleton E, Muir G, Rinnhofer K (2007) Nuyts Wilderness beetles & fire (POSTER). In: The Combined 8th Invertebrate Biodiversity & Conservation Conference 2007: Program and Abstracts: Queensland Museum, 2 -7 December 2007, Brisbane p. 1. Conference Organising Committee, Brisbane.
31. Van Schoubroeck P, Long S (2007) Disturbance history of coral reef communities in Bills Bay, Ningaloo Marine Park, 1975-2007. Department of Environment and Conservation, Western Australia, Marine Science Program, Data Report MSP-2007/06, Department of Environment and Conservation, Kensington, WA. 43 p.
32. Waples K (2007) Current marine research in the Ningaloo Marine Park, 2007. Department of Environment and Conservation, Kensington, WA. 59 p.
33. Wege JA (2007) (1782) Proposal to conserve the name *Stylidium affine* against *S. drummondii* (Stylidiaceae). *Taxon* 56, 613-614.
34. Wege JA (2007) Donatiaceae. In: *Flowering Plant Families of the World* (by VH Heywood, RK Brummitt, A Culham *et al*.), p. 132. Firefly, London.
35. Wege JA (2007) Stylidiaceae: triggerplant and stylewort family. In: *Flowering Plant Families of the World* (by VH Heywood, RK Brummitt, A Culham *et al*.), Firefly, London. 312-313 p.

# CURRENT COLLABORATION WITH ACADEMIA
## (Student Projects)

| DEC Officer | Student | Project Title | Degree /level | Duration (yr - yr) | University Academic | 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 | Prof J Majer | Curtin University of Technology |
| Algar, David | S Hilmer | Ecophysiology of the feral cat in Australia | PhD | 2006-2009 | Dr E Schieucher | Johan Wolfgang Gothe University |
| Algar, David | K Koch | Genetic diversity and phylogeography of Australian cats | PhD | 2009-2011 | Dr K Schwenk | Johan Wolfgang Gothe University |
| Biggs, James | T Fouche | An study of the light pollution in Perth | 3rd yr research project | 2009 | Prof M Zadnick | Curtin University of Technology |
| Biggs, James | O Giersch | An examination of solar coronal mass ejections and their relationship to the solar-terrestrial environment | PhD | 2007-2010 | Prof M Lynch | Curtin University of Technology |
| Burbidge, Allan | C Jackson | Damage to canola crops caused by Carnaby's black cockatoo | MSc | 2008-2009 | Dr G Wardle | University of Sydney |
| Burrows, Neil | J Reid | Factors influencing stand structure, distribution and recruitment of *Acacia burrowsiana* | Hons | 2008-2009 | Dr P Groom, Dr P Grierson | Curtin University of Technology / University of Western Australia |
| Burrows, Neil | C Bishop | Impacts of fire regimes and *Phytophthora* on vegetation communities of the southern forests | PhD | 2005-2009 | Dr G Wardell-Johnson | University of Queensland |
| Burrows, Neil | P Langlands | Interactions between fire and spiders in arid zone rangelands | PhD | 2005-2009 | Dr K Brennan | University of Western Australia |
| Burrows, Neil | J Fissioli | Predicting the distribution of tingle associations in south-west Australia | PhD | 2005-2009 | Dr G Wardell-Johnson | Univeristy of Queensland |
| Byrne, Margaret | R Thavornkanlapachai | Understanding the importance of gene flow for conservation of rare plants in fragmented | Hons | 2008 | P Ladd | Murdoch University |

| DEC Officer | Student | Project Title | Degree /level | Duration (yr - yr) | University Academic | University |
|---|---|---|---|---|---|---|
| | | landscapes | | | | |
| Byrne, Margaret | A Shah | Genetic diversity and differentiation in *Banksia nivea* | Hons | 2008 | Dr M Moody | University of Western Australia |
| Byrne, Margaret | L Kroiss | Gene flow and hybridisation among *Cullen* ssp. | PhD | 2006-2008 | Dr M Ryan | University of Western Australia |
| Cochrane, Anne | B Vincent | Germination physiology and ecology of the priority and significant flora on RNO tenements at Bandalup Hill Nickel mine in relation to recruitment and regeneration | PhD | 2005-2009 | Dr J Plummer | University of Western Australia |
| de Tores, Paul | J Clarke | Translocation outcomes for the Western ringtail possum (*Pseudocheirus occidentalis*). | PhD | 2006-2010 | K Warren, I Robertson, M Calver | Murdoch University |
| de Tores, Paul | H Grimm (nee McCutcheon) | Possum ecology and health on the Geographe Coastal Plain | PhD | 2006-2010 | K Warren, I Robertson, M Calver | Murdoch University |
| de Tores, Paul | G Bryant | 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 | PhD | 2006-2010 | T Fleming, K Warren | Murdoch University |
| de Tores, Paul; Marlow, Nicky; Sutherland, Duncan | 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 | K Wilson | Quantifying genetic effects of habitat fragmentation on western ringtail possum in south-west WA | Hons | 2009 | P Spencer | Murdoch University |
| Friend, Tony | R Vaughan | Epidemiological aspects of health management of Gilbert's potoroo (*Potorous gilbertii*) | PhD | 2006-2008 | Dr K Warren, Dr S Fenwick | Murdoch University |
| Friend, Tony | J Austen | Trypanosomes of some Western Australian mammals: phylogenetics and ecology | PhD | 2006-2011 | Dr U Ryan | Murdoch University |
| Friend, | R Vaughan | Epidemiological | PhD | 2008 | Dr K Warren, Dr S | Murdoch |

| DEC Officer | Student | Project Title | Degree /level | Duration (yr - yr) | University Academic | University |
|---|---|---|---|---|---|---|
| Tony | | aspects of health management of Gilbert's potoroo (*Potorous gilbertii*) | | | Fenwick | 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 | Dr R Bencini, Dr H Mills | University of Western Australia |
| Friend, Tony | J Pridham | Finding a dietary surrogate for Gilbert's potoroo (*Potorous gilbertii*) | Hons | 2009-2010 | Dr G Luck | Charles Sturt University, NSW |
| Huisman, John | R Dixon | Systematics of Sargassum (Phaeophyceae) in Australia | PhD | 2008-2010 | Dr J Huisman | Murdoch University |
| Macfarlane, Terry | U Sirisena | Systematic studies on *Thysanotus* | PhD | 2006-2009 | Dr J Conran | Adelaide of Adelaide |
| 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 , Dr E van Etten | Edith Cowan University |
| McCaw, Lachie | J Hollis | Coarse woody fuel availability and consumption in Australian forests fires | PhD | 2007-2010 | Dr W Anderson, Dr J Chapman, Dr P Ellis, 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 of Technology |
| 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, Dr M Boer | University of Western Australia |
| McKenzie, Norm; Wayne, Adrian | P Webala | Bat community structure and habitat use across disturbance regimes in jarrah forests, south-west Western Australia | PhD | 2007-2009 | Prof S Bradley, Dr M Craig | Murdoch University |
| Morris, Keith; Johnson, Brent | K Rayner | Ecology of chuditch in the western woodlands of the Goldfields | Hons | 2009 | Dr H Mills | University of Western Australia |
| Morris, Keith; Johnson, Brent | C Smart | The relationship between water rat (*Hydromys chrysogaster*) distribution and water quality on the Swan Coastal Plain | Hons | 2009 | Dr H Mills | University of Western Australia |
| Morris, Keith | N Willers | The use of the contraceptive deslorelin to manage overabundant rock-wallaby populations | PhD | 2007-2010 | Dr R Bencini | University of Western Australia |

| DEC Officer | Student | Project Title | Degree /level | Duration (yr - yr) | University Academic | University |
|---|---|---|---|---|---|---|
| Radford, Ian | A Cook | Can we protect threatened mammals from severe wildfires in the north Kimberley? | MSc | 2008-2011 | Dr R Bencini, Dr H Mills | University of Western Australia |
| Robinson, Richard | F (Paco) Tovar | Fungi causing decay in coppiced bluegum stumps | PhD | 2006-2009 | Dr T Burgess, Dr G St J Hardy | Murdoch University |
| Rye, Barbara | C Motsi | Molecular systematics of *Pimelea* (Thymelaeaceae) | PhD | 2005-2009 | Dr M Van der Bank | University of Johannesburg |
| Shearer, Bryan | P Barua | Use of *Lambertia* spp. as a model system to study pathogenicity of *Phytophthora cinnamomi* | PhD | 2008-2011 | Dr G Hardy | Murdoch University |
| Shearer, Bryan | L Eshraghi | Use of *Arabidopsis* as a model system to study mechanisms of action of phosphite | PhD | 2008-2011 | Dr G Hardy | Murdoch University |
| Shearer, Bryan | P Scott | Tuart decline | PhD | 2004-2008 | Dr G Hardy | Murdoch University |
| Shearer, Bryan | R Hooper | Wandoo decline | PhD | 2004-2009 | 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 | C Bishop | Impact Phytophthora cinnamomi | PhD | 2006-2009 | Dr G Wardell-Johnson | University of Queensland |
| Simpson, Chris | D Holley | Northwest dugong population and habitat use | PhD | 2007-2009 | Dr P Lavery | Edith Cowan University |
| Simpson, Chris | A Hill | Factors influencing the establishment of marine protected areas in Western Australia | PhD | 2007-2009 | Dr S Shea | Notre Dame University |
| Simpson, Chris; Kendrick, Alan; Wilson, Shaun; Waples, Kelly | various | Science Connections: Marine Science Mentoring Program | U/grad. | 2009 | Dr M van Keulen | Murdoch University |
| Stukely, Mike | A Rea | Classical and molecular taxonomy and pathogenicity testing of *Phytophthora* species | PhD | 2007-2010 | Dr G Hardy | Murdoch University |
| van Leeuwen, Stephen | G Page | Ecology and physiology of Mulga types at West Angelas, Pilbara, Western Australia | PhD | 2005-2009 | 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, | C Pacioni | A conservation | PhD | 2006- | Prof I Robertson, | Murdoch |

| DEC Officer | Student | Project Title | Degree /level | Duration (yr - yr) | University Academic | University |
|---|---|---|---|---|---|---|
| Adrian | | conundrum: the population and epidemiological dynamics associated with recent decline of woylies (*Bettongia penicillata*) in Australia | | 2009 | Dr P Spencer | University |
| Wayne, Adrian | K Rodda | Resource availability and woylie declines in south-west Western Australia | PhD | 2007-2010 | Dr K Bryant | Murdoch University |
| Wayne, Adrian | U Parkar | Blasocystis and other protozoa in wildlife | PhD | 2006-2009 | Dr A Thompson | Murdoch University |
| Wayne, Adrian | P Roger | Predator profiling as a tool for the conservation of the woylie (*Bettongia penicillata ogilbyi*) | Hon | 2008-2009 | Dr J Meyer | University of Western Australia |
| Wayne, Adrian | R McCracken | The status of key south-west Australian brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*) populations and the role of animal health and disease in the absence of recovery from population decline. | Hon | 2009 | Dr K Robert | University of Western Australia |
| Wittkuhn, Roy | B Pekin | Influence of fire frequency and resource gradients on the structure and diversity of the jarrah (*Eucalyptus marginata* Donn ex Sm.) forest of south-west Australia | PhD | 2006-2009 | Dr P Grierson, Dr M Boer, Dr C Macfarlane | University of Western Australia |
| Yates, Colin | K Maher | Fire, fragmentation and mammals, synergistic impacts on ecosystem dynamics | PhD | 2004-2008 | Prof R Hobbs | 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 | 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 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| ANZEC / CRC for Australian Weed Management | Technical Group for weeds of conservation significance | Nil | G Keighery (0.05) |
| ARC Linkage, Murdoch University | The role of disease factors in regulating fauna populations | $30k 2007-2009 | K Morris (0.05), A Wayne (0.10) |
| ARC Linkage, Murdoch University | Conservation of the threatened western ringtail possum, *Pseudocheirus occidentalis*: Is translocation a solution? | $110k per annum over three years 2007-2009 | P de Tores (0.15) - $15 000 pa over three years<br>$25 000 pa ($5,000 for each of three PhD students) from SD |
| 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)<br>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 for three years | D Pearson (0.5)<br>$20k cash for three years; $112k in kind |
| Aust Marine Science Assoc. (WA) | Rottnest Young Scientist Workshop | Nil | S Armstrong (0.01)<br>$500 sponsorship |
| Australian Institute of Marine Science | Comparative marine biodiversity survey of the Rowley Shoals marine protected areas | Nil | T Holmes (0.05) |
| Australian Institute of Marine Science | Coral reef fish recruitment study | AIMS funded field trip | S Wilson (0.1) T Holmes (0.1) |
| Australia's Virtual Herbarium Trust | AVH: Australia's Virtual Herbarium: Databasing of cryptogam collections | 2007-2008 ($48.5k) | C Parker (0.1),<br>S Carroll (0.1) |
| Australian Museum | Kimberley island biodiversity asset identification | Nil (component of NHT2 funding to DEC) | L Gibson (0.7), F Koehler (1.0), V Kessner (0.75) |
| Australian Wildlife Conservancy | Integrated management of introduced predators in the rangelands | $45k pa 2006-2009 | D Algar (0.5), M Onus (0.5), H Hamilton (0.5) |
| Australian Wildlife Conservancy | Woylie Conservation Research Project | Nil | A Wayne (0.8), C Vellios (0.8), C Ward (0.8), M Maxwell (0.8) |
| Avon Catchment Council | Aquatic Baselining the biodiversity of the Avon NRM region | ACC Funding | A Pinder (0.05), S Jones (1.0), A Leung (1.0), D Halliday (1.0) and C Francis (1.0) |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| Avon Catchment Council | Genetic anaysis of Eucalyptus cupraea and Grevillea phanerophleba | $34.7k | M Byrne (0.1) |
| Avon Catchment Council | Terrestrial Baselining of natural diversity data in Avon NRM Region | ACC funding | P Gioia (0.1), J Richardson (0.8), B Bayliss (0.8), T Gamblin (1.0), B Glossop (0.1), J Harvey (0.8) |
| BHP Billiton (Iron Ore and Nickel West), Rio Tinto | Understanding Mulga Project | $124k and $64k | B Maslin (0.75), J Reid (1.0) |
| BHP Billiton Iron Ore | Identification Botanist position at the Western Australian Herbarium | $105k | S Dillon (1.0) |
| BHP Billiton Iron Ore, Botanic Garden & Parks Authority | Pilbara Environmental Weed Posters | Nil | S van Leeuwen (0.01) |
| 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 (0.1), J Fielder (0.1), G Liddelow (0.2), C Carpenter (0.1), P Van Heurck (0.1), A Wills (0.2) |
| 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? | $84.5k p.a. | P de Tores (0.50), A Glen (1.0), D Sutherland (1.0), R Hill (1.0), S Garretson (1.0), L Bloomfield (0.75), L Strümpher (0.75), J Asher (0.01), N Powell (0.01) |
| Caring For Our Country | Fauna reconstruction in the rangelands | $221k | K Morris (0.3), J Dunlop (1.0) Goldfields |
| Chevron Australia | Monitoring mammals on Barrow Island | $6k pa for five years, completed Nov 2008 | K Morris (0.05), AA Burbidge (0.05) |
| Clarion U and Oil Region Astronomical Society | Internet telescope | $1k | J Biggs (0.02), A Verveer (0.1) |
| Commonwealth Department of Environment and Water Resources (DEW), (formerly DEH) | Preparation of a recovery plan for the quokka, *Setonix brachyurus* | $38k, draft completed 2008 | P de Tores (0.05) |
| Commonwealth Department of Environment and Water Resources (DEW), (formerly DEH) and Murdoch University | The uptake of cat baits by non-target fauna in the south-west of WA | $ 42k | K Morris (0.1), P deTores (0.2) |
| Commonwealth Department of Environment and Water Resources (DEWHA), 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) |
| CSIRO | NW Shelf Research inventory | $15k | K Waples (0.05), C Simpson (0.05) |
| CSIRO Entomology, ESPM Dept. & Essig Museum of Entomology, University of California, Berkeley, CA | Pilbara Biological Survey:Australian National Insect Collection curation and identification of Coleoptera | Nil | N Guthrie (0.1) |
| CSIRO Sustainable Ecosystems | Fire regimes and biodiversity decline in the Kimberley | $101.4k for three years, 2006-2009 | I Radford |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| 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) |
| CSRIO, Australian Wildlife Conservancy | Systematics and population history of Ground Parrots | $11k | AH Burbidge (0.05) |
| CSRIO, Australian Wildlife Conservancy | Explaining and predicting the occurrence of Night Parrots (*Pezoporus occidentalis*) using GIS and ecological modelling | $38k | AH Burbidge (0.05) |
| Curtin University of Technology | Gamma ray burst – optical follow up | Nil | R Martin (0.05) |
| Curtin University of Technology, Department of Environmental and Aquatic Sciences | Pilbara Biological Survey: Ant identifications | Nil | B Durrant (0.1) |
| 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. | $25k p.a. for two years 2008-2009 | K Morris (0.05), N Burrows (0.05) |
| Department of Fisheries | Introduced Marine Pests | $28k for 2006-2007 | J Huisman (0.3) (Salary) |
| Department of Fisheries, WA | Resource Condition Monitoring of Mangroves in Northwest Australia | Nil | K Friedman (0.02) $28k DEC |
| Department of Water | Habitat requirements of Pilbara river pool invertebrates | DoW to provide $83.3k in 2008-2009 | A Pinder (0.1), A Leung (0.9) |
| DSE (Victoria) and Department DEWHA (Commonwealth) | PAPP toxicosis and cat bait pellet development | $100k per year from DEWHA | D Algar (0.05), K Morris (0.02)<br>$10k in kind from DEC |
| Edith Cowan University | Monitoring movement pattens of marine fauna using Vemco VRAP Accoustic tracking system | Nil | A Kendrick (0.01) S Wilson (0.01) $40k DEC |
| Edith Cowan University | Spatial and temporal patterns in the structure of inter-tidal rocky platform communities of the SIMP and MMP | $2.5k | A Kendrick (0.05), M Rule (0.05) |
| Flinders Univeristy South Australia | A satellite tracking study of feral camels in WA | $40k from Flinders Univeristy | B Ward (0.1) $25k from DEC |
| Flinders Univeristy South Austyralia, Anglo Gold | Satellite tracking of feral camels | Nil | B Ward (0.1), G Liddelow (0.1) |
| Forest Products Commission and Integrated Tree Cropping | Genetic analysis of *Santalum album* | $10.7k | M Byrne (0.05), B Macdonald (0.1) |
| Fortescue Metals Group | Understanding Mulga Project | $64k | B Maslin (0.75), J Reid (1.0) |
| Future Farm Industries CRC | Biodiversity Program Project - Management of weed and genetic risk in perennial landuse systems | $322k for 3 years (2008-2011) | M Byrne (0.3), B Macdonald (0.2) |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| Gnangara 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 Gnangara Sustainability Strategy, Swan NRM, NACC, South-Coast NRM, SWCC NRM | J Richardson (0.05) |
| GCN (Gamma Ray Burst Communication Network), USA | Supernova search | Nil | R Martin (0.05) |
| Griffith University | Land & Water Australia funded TraCK project examining bioregionalisation of northern Australian riverine fauna | $10k | A Pinder (0.05), D Cale (0.05) |
| IAU Minor Planet Center, Harvard University | Asteroid tracking - Astrometry of minor planets, comets and targets of opportunity | Nil | J Biggs 0.03 , A Verveer (0.02) |
| 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 | $1.1k for four 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 $170k for two years | L Gibson (0.7), N McKenzie (0.3) |
| 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 | $7.4k 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 | J Biggs 0.01 A Verveer (0.05), R Tonello (0.05) |
| Millennium Seedbank Project | Seed collection, storage and biology | $210k per year to 2009 | A Cochrane (0.8), D Coates (0.1) |
| Murdoch University | Woylie Conservation Research Project | Nil | A Wayne (0.8), C Vellios (0.8), C Ward (0.8), M Maxwell (0.8) |
| Murdoch University | Monitoring management effectiveness: Monkey Mia dolphins | $15k-$25k p.a. for six years (2006/07-2012/13) (from Shark Bay Marine Park budget) | C Simpson |
| Murdoch University | An ecosystem approach to estimating the viability of dolphin populations exposed to industrial/port activities | $10k p.a. for three years (2007-2009) | C Simpson |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| Murdoch University | Little Penguin Study: Development of a monitoring protocol | $27.5k for three years (2006-2008) | C Simpson |
| Murdoch University | Epidemiology of marri canker | Nil | B Shearer (0.4) |
| National Heritage Trust | Western ground parrot recovery | $200k | AH Burbidge (0.1) South Coast Region |
| National Heritage Trust 2 | Seed conservation program | $85k p.a. to 2008 (SCRIPT) | A Cochrane (0.5) |
| National Heritage Trust 2 (Kimberley Land Council) | Kimberley island biodiversity asset identification – Phase 1 (incl. indigenous liaison and participation) | $2.7m for 2006-2009 (incl. $165k for two years) | 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) |
| National Heritage Trust Regional Competitive Component | Securing a future for the dibbler – cross-regional recovery program | $108k p.a. for three years, 2007-2009 | T Friend (0.1} |
| Perth Zoo | Woylie Conservation Research Project | $10.5k Wildlife Conservation Action | A Wayne (0.8), C Vellios (0.8), C Ward (0.8), M Maxwell (0.8) |
| Perth Zoo, Wildlife Conservation Assocation | Fauna reconstruction in the rangelands | $5k | K Morris (0.3), J Dunlop (1.0) Goldfields Region |
| Ravensthorp Nickel | Determination of hybrid status of *Eucalyptus stoataptera* | $28k | M Byrne (0.1), B Macdonald (0.1) |
| Rio Tinto | Identification Botanist position at the Western Australian Herbarium | $47K | G Guerin – J Hurter (1.0) |
| Rio Tinto | Pilbara Environmental Weed Posters | Nil | S van Leeuwen (0.01) |
| Rio Tinto (West Angelas Coondewanna West Environmental Offsets) | Pilbara Wattle | Nil | B Maslin (0.1), S van Leeuwen (0.05) |
| Rio Tinto Iron Ore (West Angelas Coondewanna West Environmental Offsets) | Fire-Mulga study: post burn monitoring & Tussock Grasslad Survey of the Hamersley Range | $20k | S van Leeuwen (0.01) |
| Scitech Planetarium, UWA, STAWA | Astronomy education | Nil | A Williams (0.05) |
| SCNRM | Woylie Genetics and Serology Study | $7.6k SCNRM | A Wayne (0.05) |
| SCRIPT | Gilbert's potoroo recovery program | $187k p.a. for three years | T Friend (0.75) |
| SCRIPT | Numbat recovery program, South Coast | $34k p.a. for three years | T Friend (0.05) |
| SCRIPT | Dibbler distribution and ecology in Fitzgerald River NP | $60k p.a. for three years | T Friend (0.1) |
| Secretariat of the Pacific Community | Reef Fisheries Observatory Pacific Regional Oceanic and Coastal Fisheries (PROCFish) project | Travel funds from external source (European Union) | K Friedman 0.02 |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| South African National Biodiversity Institute (SANBI) | Guidelines for bioclimatic modelling, monitoring and data management. | Nil | R McKellar, I Abbott, C Yates, P Gioia DEC contribution $225 914 |
| South Australian Dept Environment and Heritage | Woylie Conservation Research Project | Nil | A Wayne (0.8), C Vellios (0.8), C Ward (0.8), M Maxwell (0.8) |
| South West NRM | Genetic and eoclogical viability of Busselton Ironstone communities | $102.7k for four years (2005-2009) | M Byrne, B Macdonald, C Yates, N Gibson, M Langley |
| 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 - Monitoring gravitational microlenses | Nil | R Martin (0.2), A Williams (0.25), A Verveer (0.06), R Tonello (0.06) |
| University of Adelaide | Wetland monitoring program/Avon Baselining program – rotifer and cladoceran identifications - Dr R Shiel | Nil | A Pinder (0.05), D Cale (0.05)<br>DEC contribution $10k |
| University of California, Berkeley and Lawrence Hall of Science | Hands on Universe - Internet telescope | $1k | J Biggs (0.01), A Verveer (0.05), R Tonello (0.05) |
| University of Nebraska, Omaha USA | Fire ecology of hummock grasslands | Nil $; in-kind | B Ward (0.1) |
| University of Northern Arizona | Pilbara biological survey diatom identifications - Prof D Blinn | Nil | A Pinder (0.05) , M Lyons (0.05) |
| University of Queensland, University of WA | Broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems | ARC Linkage External: $120k for 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)<br>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 burning and biomass smoke in Australian towns and cities | Nil | L McCaw (0.05)<br>DEC $10K for three years |
| University of Western Australia | Assessing fish communities in Shoalwater Islands Marine Park | Nil | K Friedman (.01 ) A Kendrick (.01 ) S Wilson (0.01) M Rule (.05 ) K Brancroft (0.01) T Holmes (0.05) $12k DEC |
| University of Western Australia | Processes in lateritic soil in Western Australia | Nil - PhD student - A Koning | B Shearer (0.04) |
| University of Western Australia | Mode of action of phosphonate in native hosts to *Phytophthora cinnamomi* | Nil - PhD student - B Komorek | B Shearer (0.04) |
| Unviersity of WA, SWCC, SCRIPT | Aboriginal landscape transformations in south-west Western Australia | ARC Linkage | N Burrows (0.01)<br>DEC $6k for three years |

| Partnership Name i.e. CRC, Govt Depts, Universities, Industries, Other (sponsorships etc) | Project | External funding and source 2008/2009 ($) | DEC Involvement (in kind and $) |
|---|---|---|---|
| WA Naturalists Club, Lotteries West | PUBF: Perth Urban Bushland Fungi project | $14k 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 | Nuyts Wilderness Community Trust funds annual collection curation | P Van Heurck (0.1), T Middleton (0.1), WNNPA volunteers (2 x 0.2 = 0.4) |
| WAMSI | North West Marine Research Inventory Project | $185k (DEWHA, DOIR, DoF, Chevron, Inpex), | K Waples (0.05) DEC $15k for 2007-2008 |
| Western Areas NL | Ecology of chuditch in the western woodlands | $38k | K Morris (0.1), B. Johnson (0.2) |
| Western Australian Marine Science Institution | North West Marine Research Inventory Project | $15k in 2007/08 | K Waples (0.05) |
| Western Australian Museum | Inventory and databasing of marine faunal records from the NW atolls | $60k in 2007-2008 | T Holmes (0.05) |
| Western Australian Museum | Systematic revision of the endemic Australian scorpion genus *Urodacus* (Scorpiones, Urodacidae) | ABRS and WAM for three years | B Durrant (0.2) DEC contribution of $18k |
| Western Australian Museum | Pilbara Biological Survey | $500k in-kind in 2005-2009 | N McKenzie (0.6), AH Burbidge (0.9), L Gibson (0.1) |
| Western Australian Museum | Kimberley island biodiversity asset identification | Nil (component of NHT2 funding to DEC) | L Gibson (0.7), R Palmer (1.0) |
| Western Australian Museum | Inventory and databasing of marine faunal records from the NW atolls | Nil | T Holmes (0.01) $60k for 2007-2008 (DEC funded) |
| Western Australian Police | Forensic services (botanical identifications) | $12K in 2007-2008 | N Lander (0.1) |
| Woodside Energy | Taxonomic Studies on Burrup Flora | $120k | R Butcher (0.25), K Shepherd (0.25), J Wege (0.25) |
| 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 (0.50), A Glen (1.0), D Sutherland (1.0), R Hill (1.0), S Garretson (1.0), L Bloomfield (0.75), L Strümpher (0.75), J Asher (0.01), N Powell (0.01) |

Note: 1k = $1 000

# SUMMARY OF RESEARCH PROJECTS by REGIONS

## (DEC, IBRA/IMCRA and NRM)

| DEC Region | IBRA/IMCRA | NRM Region | Project Title | Page |
|---|---|---|---|---|
| **BIODIVERSITY AND CLIMATE CHANGE UNIT: COLIN YATES** | | | | |
| South Coast, Warren, Wheatbelt, Swan, Midwest | Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren | Avon, Northern Agricultural, South West, South Coast, Swan | Biodiversity and climate change in megadiverse ecosystems | 59 |
| South Coast, Warren, Wheatbelt, Swan, Midwest | Avon Wheatbelt, Esperance Plains Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren | Avon, Northern Agricultural, South Coast, South West, Swan | Assessing the combined effects of climate change and land transformation on the geographic ranges of keystone and iconic species in the south-west Western Australia | 60 |
| South Coast, Warren, Wheatbelt, Swan, Midwest | Avon Wheatbelt, Esperance Plains Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren | Avon, Northern Agricultural, South Coast, South West, Swan | Temperature thresholds for recruitment in south-west Western Australian flora | 61 |
| Midwest | Geraldton Sandplains | Northern Agricultural | Climate change risks for biodiversity and ecosystem function in species-rich shrublands | 61 |
| South Coast, Warren, Wheatbelt | Avon Wheatbelt, Esperance Plains, Jarrah Forest, Mallee, Warren | Avon, South Coast, South West | Protecting the safe havens: will granite outcrop environments serve as refuges for flora threatened by anthropogenic climate change? | 62 |
| **BIOGEOGRAPHY PROGRAM: STEPHEN VAN LEEUWEN** | | | | |
| Pilbara | Pilbara | Rangelands | Pilbara regional biological survey | 64 |
| Kimberley | Victoria Bonaparte, North Kimberley, Dampierland | Rangelands | Kimberley islands biological survey | 65 |
| Goldfields, Midwest | Avon Wheatbelt, Coolgardie, Murchison, Gascoyne, Yalgoo | Rangelands, Northern Agricultural | Floristic surveys of the banded iron formation (BIF) ranges of the Yilgarn | 66 |
| South Coast | Esperance Plains, Mallee | South Coast | Biological survey of the Ravensthorpe Range | 67 |
| Midwest | Geraldton Sandplains | Northern Agricultural | Survey and conservation value assessment of wetlands of the Hutt River | 68 |
| Swan, South West | Swan Coastal Plain | Swan, South West | Floristic survey of the remnant heaths and woodlands of the Swan Coastal Plain | 69 |
| All | All | All | Ecomorphological clues to community structure, bat echolocation studies | 70 |
| **FAUNA CONSERVATION PROGRAM: KEITH MORRIS** | | | | |
| Midwest, Goldfields | Carnarvon, Gascoyne, Murchison | Rangelands | Development of effective broadscale aerial baiting strategies for the control of feral cats | 71 |
| Midwest | Avon Wheatbelt, Yalgoo | Northern Agricultural, Rangelands | Sustained introduced predator control in the Rangelands | 72 |

| DEC Region | IBRA/IMCRA | NRM Region | Project Title | Page |
|---|---|---|---|---|
| South Coast, Warren | Esperance Plains, Jarrah Forest, Warren | South Coast, South West | Conservation of south coast threatened birds | 73 |
| Swan, South West | Swan Coastal Plain | South West | Translocation outcomes and monitoring of naturally occurring populations of the western ringtail possum, *Pseudocheirus occidentalis* | 74 |
| Swan, South West | Jarrah Forest | South West, Swan, Avon | The importance of fox, cat and native predator interactions to sustained fauna recovery in the northern jarrah forest – is there a mesopredator release effect? | 75 |
| Swan, South Coast, Wheatbelt, Warren | Avon Wheatbelt, Jarrah Forest, Mallee, Swan Coastal Plain, Warren, Yalgoo | South West, Swan, Avon, South Coast | Factors affecting establishment in the numbat (*Myrmecobius fasciatus*) Recovery Plan | 76 |
| Wheatbelt | Avon Wheatbelt | South West, Avon | An assessment of the effect of fox control on *Phascogale calura* (red-tailed phascogale) populations | 77 |
| Midwest, South Coast | Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain | Northern Agricultural, South Coast | Dibbler (*Parantechinus apicalis*) Recovery Plan | 78 |
| South Coast | Jarrah Forest | South Coast | Gilbert's potoroo (*Potorous gilbertii*) Recovery Plan | 79 |
| Midwest | Carnarvon, Geraldton Sandplains | Rangelands, Avon | Genetics and ecology of the western barred bandicoot (*Perameles bougainville*) | 80 |
| South Coast | Jarrah Forest | South Coast | Disease screening and vectors of transmission in quokkas (*Setonix brachyurus*) on the mainland and Bald Island | 81 |
| South West, Swan, Warren | Jarrah Forest, Warren | South West, South Coast | Rapid survey of quokka (*Setonix brachyurus*) in the southern forests | 82 |
| Warren | Jarrah Forest | South West | Monitoring selected vertebrate communities in the Perup Nature Reserve | 83 |
| Warren, South West | Jarrah Forest, Warren | South West | Assessing the distribution and status of the wambenger | 84 |
| Goldfields, South West, Wheatbelt, Warren | Avon Wheatbelt, Coolgardie, Jarrah Forest, Warren | Avon, South West, Rangelands | Probait trials: phase 2 | 84 |
| Wheatbelt | Avon Wheatbelt | Avon, South West | Sustained fauna recovery in a fragmented landscape (Dryandra Woodland and Tutanning Nature Reserve) | 85 |
| Wheatbelt | Avon Wheatbelt | South West, Avon | Return to Dryandra | 85 |
| South Coast, Swan, South West, Warren, Wheatbelt | Avon Wheatbelt, Esperance Plains, Jarrah Forest, Mallee | South West, Swan, Avon, South Coast | Implementation of the Recovery Plan for the chuditch, *Dasyurus geoffroii* | 87 |
| Midwest | Geraldton Sandplains | Northern Agricultural | Management of overabundant marsupials – North Island tammar wallaby case study | 87 |
| Pilbara | Pilbara | Rangelands | Monitoring of mammal populations on Barrow Island | 88 |
| Wheatbelt, Katanning work centre | Mallee | Avon Catchment | Factors affecting fauna recovery in the Wheatbelt – Lake Magenta and Dunn Rock Nature Reserves | 89 |
| Goldfields | Murchison, Gascoyne | Rangelands | Rangelands Restoration – reintroduction of native mammals to Lorna Glen | 90 |
| Swan, Midwest | Avon Wheatbelt, Geraldton Sandplains, Murchison, Pilbara, Swan Coastal Plain | South West, Rangelands, Northern Agricultural | Ecology and conservation of threatened pythons in WA | 91 |
| Midwest | Swan Coastal Plain | Northern Agricultural | Implementation of the Lancelin Island Skink Recovery Plan | 92 |
| All except South | All | State wide | Improving rock-wallaby conservation and | 92 |

| DEC Region | IBRA/IMCRA | NRM Region | Project Title | Page |
|---|---|---|---|---|
| West | | | management | |
| Kimberley | Northern Kimberley, Central Kimberley, Ord Victoria Plains, Victoria Bonaparte | Rangelands | Impact of cane toads on biodiversity in the Kimberley | 93 |
| Goldfields | Central Kimberley, Central Ranges, Coolgardie, Gibson Desert, Great Victoria Desert, Gascoyne, Great Sandy Desert, Litlte Sandy Desert, Murchison, Nullabor, Ord Victoria Plains, Tanami | Rangelands | Feral camel surveys in the interior of WA | 94 |
| Warren | Jarrah Forest | South West | Identifying the cause(s) of the recent declines of woylies in south western Australia | 95 |
| Warren | Jarrah Forest | South West | Ecology of the ngwayir (*Pseudocheirus occidentalis*) and koomal (*Trichosurus vulpecula* hypoleucus) in the jarrah forest | 97 |
| Swan, Goldfields | Coolgardie, Swan Coastal Plain | Swan, Rangelands | Conservation of Western Australian butterflies | 98 |
| Swan, South West | Swan Coastal Plain | Swan | Native earthworms (Oligochaeta) of the Swan Coastal Plain: biodiversity, distribution and threatening processes | 99 |
| **FLORA CONSERVATION PROGRAM: DAVID COATES** | | | | |
| South Coast, Midwest, Swan, Wheatbelt, Goldfields | Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Mallee, Murchison, Swan Coastal Plain, Yalgoo | Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan | Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora | 100 |
| Wheatbelt | Avon Wheatbelt, Swan Coastal Plain | Avon, Northern Agricultural, South Coast, Swan | Genetic and ecological viability of plant populations in remnant vegetation | 102 |
| Wheatbelt, Midwest, Swan, South West, South Coast, Warren | Avon Wheatbelt, Esperance Plains, Jarrah Forest, Mallee, Swan Coastal Plain, | 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 | 103 |
| Midwest | Yalgoo | Northern Agricultural | Assessment of genetic diversity, key population processes and evolutionary relationships in the Banded ironstone endemic *Acacia woodmaniorum* and its close relatives | 105 |
| All | Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Gascoyne, Geraldton Sandplains, Great Sandy Desert, Hampton, Jarrah Forest, Mallee, Murchison, Nullabor, Swan Coastal Plain, Warren, Yalgoo | 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 | 106 |
| Midwest, South Coast, South West, Wheatbelt | Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren | Avon, Northern Agricultural, South Coast, South West, Swan | Experimental translocation of Critically Endangered plants | 107 |
| Midwest, Wheatbelt, South Coast, Swan, South West, Warren | Avon Wheatbelt, Esperance Plains, Jarrah Forest, Swan Coastal Plain, Warren | Avon, South Coast, South West, Swan | Ecophysiology of rare flora restricted to shallow-soil communities | 108 |
| South West, South Coast | Esperance Plains, Jarrah Forest, Swan Coastal Plain | Avon, South Coast, South West, Swan | Integrated strategies for the control of *Phytophthora cinnamomi* using phosphite | 109 |
| Midwest, Swan, Wheatbelt, South | Avon Wheatbelt, Esperance Plains, Geraldton | Avon, South Coast, South West, Swan | Susceptibility of rare and endangered flora to *Phytophthora* | 109 |

| DEC Region | IBRA/IMCRA | NRM Region | Project Title | Page |
|---|---|---|---|---|
| West, Warren, South Coast | Sandplains, Jarrah Forest, Swan Coastal Plain, Warren | | | |
| South West, South Coast | Esperance Plains, Jarrah Forest, Swan Coastal Plain | Avon, South Coast, South West, Swan | An investigation of the epidemiology and use of novel phosphite application techniques in *Phytophthora cinnamomi* infestations in the National Parks from the South Coast of Western Australia | 110 |
| Warren, South West, Swan, Wheatbelt | Avon Wheatbelt, Jarrah Forest, Swan Coastal Plain, Warren | Avon, South Coast, South West, Swan | Selection, screening and field testing of jarrah resistant to *Phytophthora cinnamomi* | 111 |
| South West, Swan | Jarrah Forest | Avon, South Coast, South West, Swan | Dieback-resistant jarrah establishment in operational forest rehabilitation sites | 112 |
| Swan, South West, Midwest, Wheatbelt, South Coast, Warren | Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren | Northern Agricultural, Swan, Avon, South West, South Coast, Rangelands | Mundulla Yellows disease in Western Australia | 113 |
| Midwest, Swan, South West, Warren, South Coast, Wheatbelt | Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren | Northern Agricultural, Swan, Avon, South West, South Coast | Vegetation Health Service | 114 |
| Goldfields, Midwest, South West, South Coast, Swan, Wheatbelt | Avon Wheatbelt, Esperance Plains, Jarrah Forest | Avon, Northern Agricultural, Rangelands, South Coast, South West, Swan | The population ecology of Critically Endangered flora | 115 |
| Goldfields | Coolgardie | Rangelands | Causes of rarity in 4 *Tetratheca* taxa in the goldfields ranges | 116 |
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# RESEARCH ACTIVITIES

## BIODIVERSITY AND CLIMATE CHANGE UNIT

### Manager: Dr Colin Yates

Climate is a fundamental influence on where plants and animals flourish, what communities and ecosystems develop in a location and what habitat is available there. Climate affects plants and animals directly by determining the temperature regimes and water availability in an area. Climate indirectly affects plants and animals by impacting on many of the most significant forces they experience, including fire, diseases, invasive species and salinity. Climate change has the potential to significantly impact on Western Australia's natural biological diversity.

Climate research through the Indian Ocean Climate Initiative program has demonstrated that climate conditions in south-west WA have changed significantly during the past 40 years; in particular, the climate is becoming warmer and drier. Climate projections indicate that Western Australia faces ongoing climate changes. Managing the potential impacts of climate change on Western Australia's biodiversity requires sound knowledge of the vulnerability of species and communities to direct and indirect impacts.

The Biodiversity and Climate Change Unit (BCCU) focuses on research to develop an understanding of these impacts, especially the impacts on the potentially 'at risk' species, communities and ecosystems of Western Australia. This understanding provides the basis on which management responses to climate change are formulated and undertaken.

The BCCU includes research scientists from all Science Division programs. It includes strengths in:

- ecology,
- modelling,
- surveys,
- phytogeography and genetics,
- fire science.

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### Biodiversity and climate change in megadiverse ecosystems

SPP# to be allocated

*Team members*

C Yates (0.2), R McKellar (0.2), P Gioia (0.1), I Abbott (0.05). External Collaborator - G Midgley, South African National Biodiversity Institute (SANBI).

*Context*

The South West Australian Floristic Region (SWAFR) and the Cape Floristic Region (CFR) of South Africa have a shared evolutionary history and many ecological characteristics that make them ideal for comparative studies investigating the impacts of climate change on biodiversity. Such studies may yield insights that might not be gained if activities were restricted to one region alone. Species and ecosystems in both regions are under threat from a range of threatening processes and projected warming and drying of climates is expected to place biodiversity under further stress. Tools for assessing the vulnerability of biodiversity to climate change in both regions and informing response planning are urgently needed.

*Aims*

- To review methods for modelling the impacts of climate change on biodiversity and assess their suitability for application in the SWAFR and CFR.
- To review the critical role of monitoring in detecting the impacts of climate change on biodiversity,

validating model projections and measuring adaptive responses.

- To review the role of information management in science planning for climate change.

*Summary of progress (2008/09) and main findings*

- Submitted four manuscripts for publication in a scientific journal (in review).
- Developed projects for Phase 2 and 3 of the collaboration.

*Management implications*

Tools for assessing the vulnerability of biodiversity to climate change.

*Future directions (next 12-18 months)*

Implement Phase 2 of the collaboration investigating the potential for climate change to facilitate weed invasions especially mutually exchanged WA and South African plants. Continue to work with SANBI and Australian Government Department of Climate Change in developing Phase 3.

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## Assessing the combined effects of climate change and land transformation on the geographic ranges of keystone and iconic species in south-west Western Australia

SPP# to be allocated

*Team members*

C Yates (0.2), A McNeill (0.75), L Gibson (0.1), P de Tores (0.05), A Wayne (0.05).

*Context*

The climate in south-west Western Australia (SWWA) is projected to become warmer and drier. Present species and ecosystem distributions in SWWA are correlated with climate at macro-ecological scales. It is therefore expected that projected warming and drying of the climate will affect most species and ecosystems. If the geographic ranges of species change, as has been predicted and observed elsewhere, then spatially explicit information describing the new geographic ranges of species and taking into account land-use will be essential for conservation planning.

*Aim*

To model the combined effects of land transformation and projected climate change on the geographic ranges of keystone and iconic species in SWWA.

*Summary of progress (2008/09) and main findings*

- Obtained and prepared high quality species distribution data, historical and projected climate and other environmental data for modelling.
- Modelled the impacts of three climate change scenarios, two dispersal scenarios and land transformation on potential geographic ranges at 2030, 2050 and 2070 for 18 *Banksia* spp., quokka and blue breasted fairy wren.
- Submitted manuscript describing *Banksia* modelling to scientific journal (in review).

*Management implications*

Spatially explicit information on the relative sensitivities of different species and ecosystems to the impacts of climate change will be required for response planning.

*Future directions (next 12-18 months)*

- Submit quokka and blue breasted fairy wren manuscripts to scientific journals.
- Model combined effects of climate change and land transformation on geographic range of ring-tailed possum.
- Use emerging dynamic species distribution modelling methods to further understanding of risks

posed by combined effects of climate change and land transformation.

## Temperature thresholds for recruitment in south-west Western Australian flora

SPP# to be allocated

*Team members*

A Cochrane (0.2), S Schreck (0.2), A Crawford (0.1).

*Context*

Germination is one of the fundamental biological activities vital to persistence in obligate seeding species. Climate directly influences germination and seedling growth. Temperature is arguably the most important climatic variable after moisture since it synchronises germination to environmental conditions most suitable for seedling establishment. Although species have climate preferences, our knowledge of basic physiological tolerances is lacking for most native species. Assessing direct physiological constraints on recruitment (e.g. upper and lower germination temperature limits for germination) may assist our understanding of the impact of warming temperatures on the persistence of plant species at the limits of their geographic range.

*Aims*

- Investigate temperature thresholds for germination in south-west Western Australia (SWWA) flora.
- Identify potentially 'at risk' plant species.
- Incorporate these data in modelling impacts of climate change on 'at risk' species.
- Utilise these data as a basis for developing management response options.

*Summary of progress (2008/09) and main findings*

- Popular article published in Australasian Plant Conservation.
- Paper in preparation on Stirling Range species germination and seedling establishment thresholds.
- Successful completion and reporting on South Coast Natural Resource Management Inc Project 0SC1-13h investigating germination temperature thresholds of 22 *Banksia* species. Many SWWA *Banksia* species demonstrated a high degree of plasticity in germination response to temperature, although some common South Coast species (e.g. *B. praemorsa*, *B. oreophila* and *B. quercifolia*) displayed more limited ranges suggesting greater vulnerability to warming temperatures.

*Management implications*

- Increased understanding of germination temperature requirements for WA species as a basis for managing disturbance regimes such as fire.
- Contribution to climate change vulnerability assessment of WA species.

*Future directions (next 12-18 months)*

- Ongoing temperature threshold investigations for a larger range of endemic species.
- Finalise paper on 'Development of a seed-based approach for identifying flora at risk from climate warming'.
- Publication of article on *Banksia* temperature thresholds.
- Obtain on site climate data for Stirling Range using dataloggers to clarify *in situ* temperature requirements for seed germination.

## Climate change risks for biodiversity and ecosystem function in species-rich shrublands

SPP# to be allocated

*Team members*

C Yates (0.2). External collaborators - N Enright, Murodch University; K Smettem, University of

Western Australia; R Froend, Edith Cowan University; G Midgley, South African National Biodiversity Institute.

*Context*

Correlative bioclimatic models are the primary tool for predicting the impacts of projected climate change on south-west Western Australia's (SWWA) globally renowned species-rich shrublands (kwongan). These models have many untested and limiting assumptions. Empirical and experimental studies investigating the relationship between climate, ecohydrology and population dynamics are needed to develop better and more realistic mechanistic models for predicting the impacts of climate change on kwongan.

*Aims*

- To quantify seasonal patterns of water input, storage and distribution in the soil profile for shrubland sites of contrasting soil depth in relation to rainfall and plant water use.
- To quantify diurnal and seasonal patterns of plant water use among selected species from two major woody plant guilds (surface water dependent sub-shrubs; ground water dependent shrubs and small trees) for shrubland sites of contrasting soil depth.
- To quantify the effects of decreased rainfall and increased ambient temperature on plant species ecophysiology and demography, identifying potentially lethal thresholds.
- To quantify plant demographic behaviour (survivorship, growth, fecundity) among selected species from two woody plant guilds for shrubland sites of contrasting soil depth.
- To apply a simulation modelling framework that links climate, soil water dynamics, plant water use and demographic response to investigate potential impacts of climate change on plant species and communities.

*Summary of progress (2008/09) and main findings*

- Automatic weather station, tipping bucket rain gauges and volumetric soil moisture probes at up to 10, 25, 50, 100, 200, 300, 400, 500 cm depth installed across three landscape positions (high-dune, low-dune and flatland).
- Manual volumetric soil moisture monitoring system installed for top 100 cm of the soil (readings at 10, 20, 40, 60 and 100 cm) and volumetric soil moisture content sensors at 1m intervals there-after to a maximum of 500 cm at three replicate sites for each landscape position.
- Perforated PVC wells with capacitance water level recorders installed to a maximum sand depth (up to 10 m on high dunes).
- Sap flow sensors installed on three replicate plants for woody plant guilds at each of the three landscape positions.
- Replicate monitoring plots for measuring demographic behaviour of wood plant guilds established.

*Management implications*

The project will provide projections of the likely risks of adverse effects of unavoidable climate change on plant species and communities in the Mid-West Region and more generally for SWWA as a basis for determing possible management options to ameliorate the climate change threat.

*Future directions (next 12-18 months)*

Continue ecohydrology and demographic studies.

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## Protecting the safe havens: will granite outcrop environments serve as refuges for flora threatened by anthropogenic climate change?

SPP# to be allocated

*Team members*

C Yates (0.2), M Byrne (0.1). External collaborators - G Wardell-Johnson, L Mucina, Curtin University; K van Niel, University of Western Australia; S Franklin, University of Saskatchewen; S Hopper, Royal

Botanic Gardens Kew.

*Context*

Many plant and animal species have survived previous climate change by contracting to dispersed refuges where local climate conditions ameliorate regional changes. Such refuges will likely contribute to the persistence of biodiversity under projected climate change. In south-west Western Australia (SWWA) the old, highly weathered and flat landscape offers little scope for the biota to migrate to altitudinal refuges during climate change. However, the many granite outcrops (GOs) scattered across the region provide a suite of habitats and conditions not found in the wider landscape and these may ameliorate the impacts of regional climate change.

*Aims*

- To investigate the potential of GOs and their associated environments to act as refuges in the face of anthropogenic climate change across SWWA.
- How do topographic and micro-habitat features of GOs designate them as refugia?
- Do phylogeographic patterns demonstrate that GOs have acted as refuges in the past and are important reservoirs of genetic diversity?
- Are particular environments at the base of GOs more productive, and are individual plants in these environments under less stress than those in the intervening matrix?
- Are the plant communities of GOs more resilient to anthropogenic climate change disturbances than the communities of the surrounding landscape matrix?

*Summary of progress (2008/09) and main findings*

This ARC linkage project has just commenced.

*Management implications*

By identifying areas that can act as refuges under projected climate change, adaptation and conservation activities can be focused where they will provide greatest benefit.

*Future directions (next 12-18 months)*

Identify field sites and begin sampling and analyses.

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# BIOGEOGRAPHY

## Program Leader: Stephen van Leeuwen

The Biogeography Program undertakes biological surveys to provide information on the biodiversity and nature conservation priorities within Western Australia. Surveys provide data on the distribution of plants and animals and enable an understanding of regional patterns in their composition and distribution. Targeted surveys of specific regions, broad habitat types or selected plant and animal groups are also undertaken. Knowledge obtained from surveys complements the site-specific studies commissioned by other land managers, such as resource companies, and is used to provide the foundation for biodiversity planning and natural resource management across Western Australia.

These activities are aligned with the information needs of the Department of Environment and Conservation. Collaborative associations are strong with the Western Australian Museum, Australian Museum, herbaria throughout Australia and with universities, cooperative research centres, CSIRO and other research institutions. Partnerships also exist with mining companies.

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### Pilbara regional biological survey

SPP# 2002/004; SPP# 2004/002

*Team members*

N McKenzie (0.6), N Guthrie (0.1), B Durrant (0.2), AH Burbidge (0.75), S van Leeuwen (0.2), M Lyons (0.4), A Pinder (0.25), L Gibson (0.2), B Bromilow (0.2), M Langley (0.9), J Rolfe (0.95); External assistance - S Halse, P Doherty, M Harvey, R Johnstone, A Baynes, B Heterick, T Weir, D Blinn, N Gunawardene, E Volschenk.

*Context*

The Pilbara is an economically important region in Western Australia, with major and expanding mineral extraction industries, pastoral industries, etc. Effective biodiversity conservation is needed to minimise the adverse impacts of these activities and other threatening processes such as altered fire regimes. This 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 and terrestrial flora and soils to overcome low cross-taxon congruence in biodiversity models.

*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 (2008/09) and main findings*

- All sampling and sorting complete.
- Terrestrial flora identifications 80% complete.
- All terrestrial and aquatic zoological identifications complete.
- Aquatic flora identifications (macrophyte and planktonic) complete; riparian flora identifications 95% 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.
- External editor in place, and contract in place for online publication of papers as soon as they are refereed in the Records of the WA Museum.

- PBS Introduction, Small Ground-dwelling mammal, microbat, ant, and beetle papers submitted for publication.
- Drafts of the sub-fossil mammal, reptile and frog, aquatic invertebrate and spider papers completed.
- Drafts of the bird, historical bird, stygofauna, diatom and scorpion papers are in preparation.

*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)*

- Complete identifying all plant vouchers, lodge representative vouchers with the Western Australian Herbarium, compile and analyse matrices then draft and submit the flora papers for publication.
- Submit, referee and publish all papers cited above.
- Compile terrestrial plant and zoological data-sets, then analyse, interpret and write terrestrial community paper.
- Contract a specialist modeller to carry out the reserve system gap analysis.
- Undertake road show to update Pilbara communities on survey findings and outputs.

## Kimberley islands biological survey

SPP# 2007/001

*Team members*

L Gibson (0.7), F Koehler (1.0), R Palmer (1.0), M Lyons (0.3), G Keighery (0.15), N McKenzie (0.15), D Pearson (0.1), W Caton (1.0), P Handasyde (0.75), V Kessner (0.75), B Muir (0.1), M Cowan (0.1), P Kendrick (0.1), J Rolfe (0.1), A Start (External).

*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 Kimberley 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. Consequently, a comprehensive biological survey of the islands off the north Kimberley coast is required. This survey focuses on sampling vertebrate and selected groups of invertebrate fauna that are most likely to be affected by the cane toad as well as by changes to other mainland selection processes. It will also sample the terrestrial flora, soil and other environmental attributes that are indicators of biogeographical patterning, environmental health, and provide a basis for condition monitoring of the targeted survey islands.

*Aims*

- 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.
- To inform development proposals by the resources and tourism industries and to provide information for community-based natural resource management and biodiversity planning.

*Summary of progress (2008/09) and main findings*

- Dry and wet season surveys completed on Augustus, Byam Martin, Darcy, Uwins, Coronation, St Andrew and Adolphus Islands.
- Vertebrate identifications (except bats) completed for all islands above and species lists tabulated.
- Plant identifications continuing (50% complete).
- Preliminary identifications of camaenid land snail species complete for the first 13 islands.

- Coastlines article published (Department of Planning and Infrastructure magazine).
- Science Division Information Sheet completed.
- To date the survey has revealed the presence of additional island populations of many vertebrates (particularly snakes and frogs), and more than doubled the faunal species lists from most of the islands visited.
- Some notable finds among the vertebrates include:
    - the red cheeked dunnart (*Sminthopsis virginiae*), western chestnut mouse (*Pseudomys nanus*) and agile wallaby (*Macropus agilis*) were recorded for the first time on Kimberley islands, the latter record a first for all WA islands.
    - the golden-backed tree-rat (*Mesembriomys macrurus*), now restricted to the north-west Kimberley, was recorded for the first time on Augustus Island.
    - northern quolls (*Dasyurus hallucatus*) were recorded on Adolphus Island in the east Kimberley (a WA island likely to be the first invaded by cane toads).
    - the first record of a taipan (*Oxyuranus scutellatus*) from Middle Osborn Island.
    - new records of the black-headed python (*Aspidites melanocephalus*) on Boongaree and Uwins Islands.
    - a Merten's water monitor (*Varanus mertensi*) recorded for the first time on a Kimberley island (Augustus).
    - the first record of a yellow-spotted monitor (*V. panoptes*) on a Kimberley island (a species highly vulnerable to cane toad invasion).
- Preliminary results from the first 13 islands sampled revealed 63 species of camaenid land snails, 27 of these are new to science and at least one new genus also new to science.
- Species of land snail appear to be endemic to the islands and each island tends to have a unique suite of species.

*Management implications*

- Survey information provides a systematic foundation supporting nature conservation planning for reserve system design, development and management, and for understanding the distribution and conservation status of species (indigenous and introduced) and ecological communities as a basis for their management.
- Survey information provides a baseline for long-term ecological monitoring of region.

*Future directions (next 12-18 months)*

- Conduct dry and wet season surveys of Sunday, Long, Hidden, Storr, NW Molema (unnamed), Lachlan, Wulalam, Unnamed (west of Storr) and Kingfisher Islands.
- Complete all species identifications from all sites sampled.
- Compile, analyse and interpret all data-sets.
- Complete and submit final report.

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

SPP# 2007/005

*Team members*

R Meissner (1.0), W Thompson (1.0), J Allen (0.25), N Sheehy (1.0), J Wright (0.75).

*Context*

To assess the conservation significance of the flora and vegetation of the Banded Iron Formation ranges of the Yilgarn, which are little studied and under increasing pressure from the rapidly expanding iron ore mining interests south of the Pilbara.

*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 and geological unit is highly prospective for mineral exploration and resource development but is inadequately documented in respect to botanical diversity and is poorly reserved.

*Summary of progress (2008/09) and main findings*

- Five papers on Banded Ironstone Formation survey published.
- A further seven draft papers on surveys of Banded Ironstone Formation ranges in press.
- 301 quadrats established and sampled in 2008. A total of 1215 quadrats now exist for Banded Ironstone Formation ranges.
- Seventeen finalised Banded Ironstone Formation datasets released.
- Contributed to Section 16 advice on Mt Manning area.
- Contributed to Government's Banded Ironstone Formation strategic review.

*Management implications*

BIF surveys provide a 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)*

- Submit Year 4 Banded Iron Formation reports for review and publication.
- Commence floristic surveys of three mineral prospective greenstone ranges in the Yilgarn.

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**Biological survey of the Ravensthorpe Range**

SPP# 2007/006

*Team members*

A Markey (1.0), J Allen (0.4), C Wilkins (0.5), J Wege (0.1), R Barrett (External), M Barrett (External), A Williams (External).

*Context*

The biodiversity values of the Ravensthorpe Range, an area of high prospective for mineral exploration and mining, are poorly documented and understood. The Range is known for possessing high numbers of both threatened and/or locally endemic plant species and distinctive and/or threatened ecological communities. Recent and historical resource developments on the Range and in the near vicinity have had significant threatened flora and vegetation management issues. This project's principal aim is to acquire additional knowledge on the floristics of the Ravensthorpe Range and to provide a comprehensive dataset, from site base plots, on the distribution of species and floristic communities across the range and to investigate the relationship between the floristic communities and mapped vegetation units.

*Aims*

To identify the botanical and invertebrate biodiversity values of the Ravensthorpe Range.

*Summary of progress (2008/09) and main findings*

- 200 permanent floristic quadrats established over the range.
- Report on floristic survey based on the 200 quadrats released.
- Release of report by Western Australian Museum on the Short-Range Endemic invertebrates of the range.
- 67 floristic quadrats established within the mapped northern extent of the Ravensthorpe Range.
- Re-evaluation of vegetation classification for northern extent of the Ravensthorpe Range underway and being informed by data from 267 quadrats.
- Collection of herbarium material for taxonomic descriptions of putative new taxa from the range.
- Assistance provided to facilitate research on the systematics, distribution and conservation status of *Lepidosperma* and *Austrostipa* taxa on the range.

- Progress with the description and conservation assessment of 40 threatened endemic and near-endemic plant taxa.
- Ongoing advice to DEC's Environmental Management Branch on impacts of proposed developments.

*Management implications*

This survey information will provide a regional context for the assessment of impacts from proposed resource developments on the conservation values of flora and vegetation of the Ravensthorpe Range.

*Future directions (next 12-18 months)*

- Complete correlation and rectification of datasets captured by the South Coast Natural Resources Management Group's vegetation mapping project and the floristic classification generated by this project.
- Provide wider access to quadrat datasets generated by this project.

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**Survey and conservation value assessment of wetlands of the Hutt River**

SPP# 2007/010
*Team members*

A Pinder (0.1), K Quinlan (1.0).

*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 hypothesis and more thoroughly document the biodiversity values of the Hutt River (and Hutt Lagoon) catchment a survey of the wetlands within the catchment was undertaken.

*Aims*

- To describe (including sites of occurrence, within the constraints of the survey) and characterise 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 Wheatbelt (SAP) and other surveys) and locally within the study area.
- To list those assets that 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 (2008/09) and main findings*

- All samples collected during the September 2007 and February 2008 field programs have been processed, resulting in the collection of 217 species of aquatic invertebrate.
- The invertebrate fauna consists mostly of very widespread species, but three groups of species are unusual in the agricultural zone. These are northern Australian species that extend south to about Jurien, southern mesic species that have a few outlier populations in the mid-west south of the Murchison River, and a group of rare or rarely collected species without either of these biogeographic affinities
- Several assemblages are likely to be better represented in the Hutt catchments than in existing Natural Diversity Recovery Catchments.
- 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. None of these are redundant in terms of the composition of their assemblages, requiring

consideration of all faunal groups in conservation planning.

- A report has been written and submitted to the Midwest regional office in Geraldton.

*Management implications*

The report will contribute to a decision as to whether or not to invest in the Hutt as a Natural Diversity Recovery Catchment in the future. Ranking the conservation importance of the various types of wetlands will enable prioritisation of future management activities irrespective of whether the catchment is nominated as a recovery catchment. The fresh to slightly saline springs and the smaller creeks they feed should be a priority for protection as these support most of what is distinctive about the catchment and help to maintain low salinities in the main channel of the Hutt River.

*Future directions (next 12-18 months)*

Project completed.

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

SPP# 1993/038

*Team members*

G Keighery (0.2); Terrestrial Ecosystems Branch.

*Context*

The Swan Coastal Plain (SCP) is highly fragmented and impacted by settlement, urbanisation and industry. Detailed biological data at various levels is required to inform complex decisions on land use to conserve and protect biodiversity. This project delivers data from new surveys, via the Swan Coastal Plain Floristic and Reserve Survey, to relevant authorities including NGO's, local government authorities, statutory planning authorities and the Environmental Protection Authority.

*Aims*

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 individual conservation reserves. Elucidation of taxonomy of significant flora and weeds will occur as part of this process, which is linked to SPP# 1997/002 and SCP# 2007/009.

*Summary of progress (2008/09) and main findings*

- Whicher Range Floristic study completed, report released. Data released and archived, report placed on DEC website.
- Scientific paper published on flora and vegetation of Dardanup Forest Block.
- Landscope article published on new plant discoveries arising from surveys.
- Yalgorup National Park vascular plant checklist updated (250 to 600 taxa), added to databases.
- Report prepared for Main Roads Western Australia and NGO on a proposed nature reserve on the Harvey River.

*Management implications*

Having a better understanding of the conservation values of the area forms the basis for improved land use planning and decision making for biodiversity conservation on the Swan Coastal Plain.

*Future directions (next 12-18 months)*

- Complete report on Vegetation and Flora of Capel to Busselton area. Archive GIS datasets relating to this project.
- Complete paper on Flora of Mandurah deltaic islands for the Department of Planning and Infrastructure's Peel Structure Plan.
- Continue as Science Division representative on Swan Bioplan project.

- Complete report on values of Yalgorup National Park for the Dawesville-Binninup Structure Plan.
- Continue to prepare and publish taxonomic, area and floristic papers.

**Ecomorphological clues to community structure; bat echolocation studies**

SPP# 1993/028

*Team members*

N McKenzie (0.1), R Bullen (External).

*Context*

This project underpins components of the Pilbara and Kimberley islands biodiversity surveys (SPP# 2004/002 and SPP# 2007/001, respectively).

*Aims*

- To extend the strategies and sampling methods used in wildlife surveys. Guild studies such as this extend knowledge of the community structuring processes (including disturbances) that affect the composition and richness of faunal assemblages within Western Australia.
- To compile a dictionary of sonar signatures for automatically recording the composition of bat assemblages on survey sites.
- To develop ecomorphological and spectral measures of potential niche (relate them to community structuring mechanisms and species' realised foraging niches).
- To investigate metapopulation, environmental factors including disturbances and species energetic requirements, controlling the occurrence and conservation vulnerabilities of bats.

*Summary of progress (2008/09) and main findings*

- Paper published on aerodynamic cleanliness of the head/body and tail of WA bats in context of difference in species foraging strategies.
- Paper on the echolocation calls and habitat relationships of Pilbara microbats accepted for publication in Records of the WA Museum.
- Paper submitted for publication on the heart and lung mass ratios of WA bats and its relationships to differences in species' aerobic/anaerobic flight performance and energy costs, foraging strategies and roost preferences.
- Paper ready for submission on spectral characteristics of search-mode calls by Pilbara microbats, spectral parameters encoded and used in their auditory imaging and the relevance of these parameters as rapid, unintrusive measures of species foraging niche and community structure for field studies.

*Management implications*

More biodiverse surveys, and better understanding of guild and fauna structure in WA ecological communities as a basis for informed resource development decisions and conservation reserve design. Better understanding of bat distributions, energetics and nature conservation status as a basis for determining appropriate management actions and priorities.

*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.
- Build a reference library of echolocation calls for the 21 microbat species in the Kimberley as a basis for identifying ultrasound recordings made from 19 islands surveyed during the Kimberley Island survey (see SPP# 2007/001), and compile data on their foraging strategies, microhabitat use and airframe attributes.

# FAUNA CONSERVATION

## Program Leader: Keith Morris

Applied research undertaken by the Fauna Conservation Program seeks to understand the factors and processes that are critical for the conservation of Western Australia's rich and unique native fauna diversity. Ensuring the persistence of threatened species through local and landscape-scale management actions including ameliorating key threats such as predation by foxes and feral cats, inappropriate fire regimes, competition and predation by introduced rodents on islands, assessing cane toad impacts and reconstructing the fauna of rangeland and arid areas are major objectives of the Program.

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### 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).

*Context*

Control of feral cats is as one of the most important native fauna conservation issues in Australia. Development of an effective broadscale baiting technique, and the incorporation of a suitable toxin for feral cats, is cited as a high priority in the National Threat Abatement Plan for Predation of Feral Cats, as it is most likely to yield a practical, cost-effective method to control feral cat numbers in strategic areas.

*Aims*

The program is aimed at developing optimal broadscale control programs for feral cats:

- To design and develop a bait medium that is readily consumed by 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 maximise efficiency.
- To examine baiting intensity (number of baits laid/$km^2$) in relation to baiting efficiency to optimise control.
- To examine baiting frequency required to provide long-term sustained effective control.
- To assess the potential impact of baiting programs on non-target species populations and devise methods to reduce the potential risk where possible.
- To provide a technique for the reliable estimation of cat abundance.

*Summary of progress (2008/09) and main findings*

- Ongoing research to optimise baiting programs was undertaken at Lorna Glen, north east of Wiluna. Annual aerial cat baiting has maintained cat activity at 5 - 8 cats per 100km of track, which is about 15% of the activity level prior to baiting. Ongoing feral cat baiting campaigns are being conducted to develop and prove baiting strategies to provide long-term sustained and effective feral cat control.
- 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.
- Field testing of an encapsulated toxicant (PAPP) in the feral cat bait (Eradicat) commenced last 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 was repeated this year on Dirk Hartog Is., Western Australia and resulted in a significant reduction in the cat

population (> 80% removal).

- A new hair capture technique that reliably samples all individuals has been developed. This 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.

*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, particularly on Dirk Hartog Island.
- A comprehensive risk assessment of the potential impact of feral cat baiting programs on populations of non-target species is continuing in collaboration with DEWHA and Victoria DSE, 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 at sites such as Lorna Glen.

## 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).

*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 builds 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 $km^{-2}$.

*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 (2008/09) and main findings*

- Three annual introduced predator baiting programs have now been completed at Mt Gibson (2006, 2007 and 2008) and one at Karara/Lochada in 2008.
- The baiting programs have resulted in significant reductions in indices of relative abundances for cats in 2006 and 2007 at Mt Gibson, however, the baiting program in 2008 had no significant impact at either site due to rain interfering with the baiting program.
- Indices of fox abundance have been significantly reduced at Mt Gibson following all three baiting programs and also at Karara/Lochada in 2008.

- Unlike canids, which find baits more readily and will continue to eat after they are sated, cats, despite being opportunistic predators, will only consume a food item if they are hungry.
- The seasonal surveys of fox/cat/dog abundance following the 2008 winter introduced predator baiting programs at Mt Gibson and Karara/Lochada have been completed for the periods spring and summer 2008 and late summer and autumn 2009. As expected, little recruitment has occurred over the spring and early summer.
- The development of an effective and reliable hair capture technique has enabled collection of data that has been used to identify specific individuals at plots and provide estimates of population size. Results to date have demonstrated, using non-invasive DNA analysis, a large reduction in fox abundance following 1080 baiting (as presented at AWMS Conference, Perth 2008).

*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)*

- Following completion of the final baiting programs at Mt Gibson and Karara/Lochada, post-bait monitoring surveys have commenced.
- This program is to be completed by December 2009 and the results published.

## Conservation of south coast threatened birds

SPP# to be allocated

*Team members*

AH Burbidge (0.15), A Berryman (1.0), J Pinder (1.0) input from South Coast Region staff; (subject to ongoing funding).

*Context*

Identifying the conservation requirements of threatened south coast birds such as the Critically Endangered Western Ground Parrot, and the Vulnerable Western Bristlebird and western subspecies of the Western Whipbird will aid *in situ* management of these taxa. Understanding 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. Since Western Ground Parrots are declining, this species is a high priority, but solutions will come from holistic management of the landscape as a whole.

*Aims*

- To develop an understanding of the biological and ecological factors that limit the distribution and numbers of Western Ground Parrots and Western Bristlebirds, including interactions with predators, habitat requirements, and response to fire.
- To increase the survival chances of the Western Ground Parrot, Western Bristlebird and Western Whipbird and increase their total population size, through creation of management prescriptions that will benefit all threatened south coast animals.

*Summary of progress (2008/09) and main findings*

- Ground Parrot surveys continued in Fitzgerald River National Park in relation to fire; populations in this park have declined almost to zero, possibly through cat predation.
- Extra survey grids established 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.

- Ground Parrot radio-tracking trial completed; further evidence for role of predation obtained.
- Autonomous recording units trialed; suggestions developed for increased cost-effectiveness in monitoring procedures for threatened birds.
- Proposal developed for threatened fauna recovery in major south coast reserves through integrated predator management.
- Numerous media releases and presentations to community groups, general public and schools.
- High involvement of community in a dedicated volunteer program.

*Management implications*

The project will provide a basis for decision-making and management actions for the recovery of threatened (and other) fauna, especially in respect of introduced predators and fire, in important conservation reserves on the south coast.

*Future directions (next 12-18 months)*

- Finalise analysis and publish existing data on response to fire by bristlebirds.
- Continue to analyse existing video footage of Ground Parrots to determine nature of food items.
- 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 to evaluate management actions.
- Extend trials of remote recording units to provide calibration against human observers and implement procedures already developed to increase cost-effectiveness in monitoring procedures for threatened birds.
- Implement feral cat control (with monitoring) in key Ground Parrot habitat.
- Establish a captive breeding program for Western Ground Parrots.

## 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), DEC funded technical support - R Hill (0.25), S Garretson (0.25), PhD Students – J Clarke, H McCutcheon, G Bryant, Murdoch University – K Warren, I Robertson, T Fleming.

*Context*

The ability to control introduced predators at a landscape scale is central to effective conservation management and to the success of DEC's Western Shield program. However, the long-term success of Western Shield will depend not only on the Department's ability to control foxes and cats, but also on the outcome of fauna translocation programs. It is important to demonstrate these translocations can result in a long-term sustained recovery. To date, the outcome of many localised 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.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- A review of the distribution of the western ringtail possum has shown the species' current distribution to be considerably different from and more expansive than previously published accounts.
- Microsatellite markers have been developed through collaboration with researchers from Murdoch University, and an initial assessment of the genetic structure of the western ringtail possum populations has been made.
- A field survey at Locke Nature Reserve and a remnant patch of peppermint dominated vegetation within Busselton townsite where population estimates (guesstimates) had previously been derived and reported. indicated the western ringtail possum population at each site was approximately twice that previously reported.
- Western ringtail possum translocation research has met with qualified success. The monitored populations within the YNP release sites have persisted at all locations and have resulted in dispersal of recruits and what appears to be an expanding population at a minimum of one of these locations. Genetic analysis has confirmed recruitment is from the founding stock at this site. The outcomes at the Leschenault site have been less clear, with a high rate of predation loss to feral cats and pythons. Fox and cat monitoring (indices to activity and estimates of density) through the use of sandplotting implies reduced fox presence and continued cat presence.

*Management implications*

- Translocation is yet to be shown to be a viable management strategy for rehabilitated western ringtail possums (ex wildlife carers) or for western ringtail possums displaced by urban developments. In the absence of demonstrated translocation success, there is a need to examine other options to deal with displaced or rehabilitated western ringtail possums.
- Translocation of western ringtail possums has largely been driven by the need to relocate possums from development sites where habitat is destroyed and the resident possum populations displaced. There will be a continued need for translocation of these displaced possums and an additional requirement to release orphaned and injured possums which have been nurtured and/or rehabilitated by wildlife carers. In order to meet conservation and community expectations, the current high rate of loss of animals to predation by cats needs to be addressed at translocation sites.

*Future directions (next 12-18 months)*

- The three PhD programs will be completed within the next 12 months.
- Toxic baiting for control of cats was originally proposed through use of DEC's "curiosity" cat bait - this is now proposed through DEC's "Eradicat" bait and is, subject to the outcome of trials assessing the risk to non-target species.
- Trapping for foxes and cats will continue. Trapped foxes and cats will be radio collared and their fate post Eradicat baiting will be monitored.

## 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

*Team members*

P de Tores (0.75). IACRC/DEC funded: technical support - R Hill (0.75), S Garretson (0.75), L Bloomfield (0.75), L Strümpher (0.75), Casual employees: D Feeniks, IA CRC funded post doctoral research scientists – A Glen (chuditch) (1.0) and D Sutherland (varanids) (1.0). PhD students - G Bryant (Murdoch University) – pythons research undertaken in this project and in conjunction with the western ringtail possum translocation research; and J Cruz (IA CRC - University of Queensland) - brushtail possums.

*Context*

Fauna recovery within Western Australia is largely dependent upon the effectiveness of localised and large scale introduced predator control programs. However recent research and monitoring by DEC has demonstrated that abundance, distribution and recovery of some species is unlikely to be a function of a single 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 determine why translocation programs have been unable to demonstrate success.

*Aims*

- To test the mesopredator release hypothesis at the landscape and local scale.
- To assess the importance of other factors to fauna recovery and translocation success.

*Summary of progress (2008/09) and main findings*

- Sandplot monitoring and DNA analyses from collected hairs and scats has confirmed foxes and cats are present across the landscape.
- Cat density appears to be high across the landscape and not necessarily associated with a reduced fox density.
- The highest diversity of native fauna was recorded from the George Forest Block site, within the most frequently baited treatment, however this was not consistent throughout the treatment. Fox and cat density appeared lowest at George Forest Block.
- A population of woylies from the George Forest Block has persisted since translocation as part of Operation Foxglove in the 1990s. The woylie population has increased in size since the recommencement of baiting in 2006.
- Chuditch, varanid and possums are patchily distributed.
- Non-target trials of DEC's "Curiosity" cat bait have indicated further work is required to prevent ingestion of the toxin by species such as chuditch, irrespective of this toxin being 1080 or para-aminopropiophenone (PAPP).

*Management implications*

- Fox and cat control may need to be integrated through strategic baiting programs for both species.
- Broadscale cat control in the south-west is not possible until non-target bait ingestion issues have been resolved.
- The effectiveness of integrated baiting programs will need to be monitored through techniques suitable for the targeted species.

*Future directions (next 12-18 months)*

- Focus will be on the George Forest Block site addressing the effectiveness of baiting, the response by foxes and cats and the fate of the remnant woylie population. Contact telemetry will be further trialed.
- Completion of non-target cat bait ingestion trials.
- Field work completed by December 2009.
- Complete data analysis and write-up by June 2010.

## Factors affecting establishment. The numbat (*Myrmecobius fasciatus*) Recovery Plan

SPP# 1993/145

*Team members*

T Friend (0.05), K Rusten (1.0).

*Context*

The numbat is Western Australia's State mammal emblem and although currently categorised as

Vulnerable on State and EPBC listings, a 2005 IUCN review recommended that it be ranked Endangered due to recent declines of some populations and it is now listed as Endangered in 2008 IUCN Red List. After a vigorous reintroduction campaign led by DEC, there are now eight self-sustaining populations but probably less than 1000 animals in existence. Continued recovery relies partly on private conservation organisations and this project is now orientated towards monitoring populations on DEC-managed estate.

*Aims*

- To measure the success of establishment of numbat populations through reintroduction and introduced predator control.
- To attribute mortality to specific causes.
- To assess population abundance and trends. 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 (2008/09) and main findings*

- Thirteen numbats (six captive-bred, seven wild caught at Dryandra) were radio-collared and released at Cocanarup in December 2008; collars maintained on animals as long as possible.
- Numbats at Cocanarup were monitored weekly at first, reducing to monthly by six months, collecting location, survival, breeding and habitat data as well as forensic data at death.
- At the end of June 2009, seven numbats, including two females with young, were still alive at Cocanarup.
- Annual numbat abundance survey carried out at Dryandra in November 2008.
- A workshop to instruct district staff in numbat diggings was held at Dryandra in April 2009
- Paper presented at the Australian Mammal Society 52$^{nd}$ Scientific Meeting in Darwin, September 2008, entitled “Recruitment into the numbat population at Dryandra Woodland, Western Australia”.

*Management implications*

Numbat translocations have been shown to have been successful at all translocation sites apart from the northern jarrah forest and Karroun Hill NR. Further surveys in these two areas are required before concluding that numbats are absent. Management of numbat habitat requires ongoing fox control and application of appropriate fire regimes, including protection from large and intense wildfires.

*Future directions (next 12-18 months)*

- Monitoring of known numbat populations will be continued by involving District staff and community members and handing over monitoring responsibility to Districts. Regular monitoring surveys will be essential in Dragon Rocks, Karroun Hill, and the northern jarrah forest east of Mundaring, Dryandra and Boyagin. Other areas will be included if possible.
- A workshop to instruct Project Numbat community group members and Australian Wildlife Conservancy staff in techniques to assess numbat release sites will be held at Mt Gibson Sanctuary in July 2009.
- Another release of zoo-bred numbats will occur at Cocanarup in December 2009, given recovery team support.
- A survey for numbats and feral cats at Dragon Rocks is proposed in 2009/2010, with Great Southern 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.

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

SPP# 1993/149

*Team members*

T Friend (0.05).

*Context*

The red-tailed phascogale (RTP) is ranked Endangered on State, Commonwealth and IUCN threatened species lists, although a recent IUCN review recommended a downlisting 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.

*Aims*

- 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 (2008/09) and main findings*

- Hair-trapping surveys for red-tailed phascogales were carried out at Peniup, Corackerup and Holden Road Nature Reserves in Albany District. No evidence of phascogales was found.
- Fires in the western Fitzgerald River National Park in January 2008 burnt the only two known sites for red-tailed phascogales, at which radio-tracking work was proposed during this year. Further searches will be carried out in 2009/10 for surviving populations.

*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 2009/10. However it would be valuable to establish ongoing monitoring and this is likely to receive some District support.
- 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.

## Dibbler (*Parantechinus apicalis*) Recovery Plan

SPP# 1995/011

*Team members*

T Friend (0.05), T Button (0.9), L Bell (0.25).

*Context*

The Dibbler Recovery Plan 2003-2013 identifies actions to improve the conservation status of this small marsupial, ranked Endangered in State, Commonwealth and IUCN threatened species lists.

*Aims*

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 (2008/09) and main findings*

- The population study in the eastern FRNP continued in 2008/09, with three monitoring sessions at the study site. Numbers were very low following the dry winter of 2008.
- A new release of dibblers was carried out at the Peniup translocation site in October 2008, with the release of 40 dibblers from the Perth Zoo colony. Most animals released were captive-bred but a few were wild caught animals that have been in the breeding colony for two years.
- Subsequent monitoring of the Peniup trapping grids resulted in capture of five dibblers in December 2008 and of three of those again in March 2009. These results are promising and another release is scheduled for October 2009.
- Baiting trials using rhodamine-labelled non-poisonous mouse baits and dead mice were carried out on Boullanger and Whitlock Island in May and October 2009. Mammals were trapped and whiskers sampled for screening for rhodamine-B marking. Ninety percent of the mice, 45% of the dibblers and no dunnarts showed uptake of the biomarker and dibblers also showed a strong tendency to eat dead mice. Trapped King's skinks showed evidence of bait consumption.
- Dibbler surveys were not carried out in FRNP in spring 2008/09 as numbers were very low in the eastern FRNP following the dry winter and the extensive fires in the western FRNP greatly reduced the area available for dibblers.

*Management implications*

- Appropriate management for threatened fauna conservation depends on adequate knowledge of species distributions and habitat preferences.
- 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 results of the study of mouse bait uptake and scavenging of mouse carcasses have implications for mouse eradication on Boullanger and Whitlock Islands. Before any baiting operation it will be necessary to establish captive colonies of dibblers and some other vulnerable species such as skinks.

*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.
- The study of dibbler distribution in the FRNP will continue in 2009/2010, with survey activity focused on spring-early summer period.

## 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 the world's rarest marsupial. 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 involves collaborative arrangements with Perth Zoo, universities, the Foundation for Australia's Most Endangered Species (FAME), private sponsors and the Albany-based Gilbert's Potoroo Action Group.

*Aims*

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 (2008/09) and main findings*

- A census of the Mount Gardner population of Gilbert's potoroos is conducted three times a year. Numbers have remained stable since 2001 when this regime was introduced. Numbers captured at monitoring sessions of 644 trap nights have varied between 13 and 26 since 2001. The traps cover about 75% of the habitat available to the entire Mount Gardner population.
- Intensive captive husbandry methods have not produced reliable breeding, so an experiment is under way to determine whether holding animals in a free range situation with or without the captive diet, will stimulate non-reproducing animals to become reproductive. A hand-reared female that has produced no young from numerous pairings has been held in a 14-hectare enclosure in remnant bushland with a male taken from the wild for 18 months without any offspring resulting. Until now these animals have been supplied daily with the artificial diet and radio-tracking and motion-activated cameras have shown that they feed every day and spend most of their time near the feeding enclosure. The potoroos are clearly accessing fungi, however; fresh diggings can be easily found within the enclosure, and analysis of their faeces by Dr Neale Bougher has revealed 14 fungal species in scats collected over the summer.
- The translocated population on Bald Island has grown rapidly from the founder number of 10 and there may now be more potoroos on the island than at Two Peoples Bay. Twenty-seven independent potoroos, including eight of the 10 founders, were captured in the most recent field trip in June 2009, despite the removal of seven potoroos in September 2008 and January 2009.
- Release of Gilbert's potoroo will occur into an enclosure in Waychinicup National Park. As well as establishing a new population, this project will be structured as an experiment to compare the potoroos' use of the different vegetation types within the enclosure. An intensive baiting and trapping program is currently under way to remove foxes and cats the enclosure.
- A manuscript describing fungal diet of potoroos on Bald Island and Ryedene has been submitted for publication.

*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 better 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 while funding is available.
- Monitor the progress of a male and a female potoroo into the 14 ha fenced enclosure during and after the removal of supplemental feeding.
- 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.
- A paper on the dynamics of the Two Peoples Bay population of Gilbert's potoroos will be submitted for publication.

## 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.

*Aims*

- To achieve an understanding of the habitat requirements, habitat use, breeding biology and spatial organisation of the western barred bandicoot.
- To assess genetic difference between populations of western barred bandicoots on Bernier and Dorre islands 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 (2008/09) and main findings*

- Data collection for the principal aspects of this project was completed prior to 2008/09.
- Research activity over the past year has been limited to 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. This research is currently aimed at developing captive breeding protocols to avoid transmission of disease.

*Management implications*

The results of these studies, particularly relating to disease and genetics, will be of great value in managing diseases in wild populations and with 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 2009/2010.
- A paper on home range activity and nest use by western barred bandicoots on Dorre Island is near completion and will be submitted for publication during 2009/2010.

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

SPP# to be allocated

*Team members*

T Friend (0.05).

*Context*

During studies of blood parasites of Gilbert's potoroos, trypanosomes (*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 out in Albany and sent to Perth for

identification.

*Aims*

- To determine the infection rates and vectors of two blood parasites in quokkas on Bald Island, Rottnest 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 (2008/09) 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.
- Samples (rectal swabs) from Bald Island quokkas taken over three years have been cultured and Salmonella strain identified where present. Results have been collated for preparation of a publication on the influence of seasonal and demographic factors on Salmonella in Bald Island quokkas.
- Blood samples have been taken from quokkas on Bald Island and the mainland and trypanosomes have been recorded and cultured from quokka blood by PhD student Jill Austen.

*Management implications*

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

*Future directions (next 12-18 months)*

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

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

Concept Plan to be submitted and SPP# to be allocated

*Team members*

G Liddelow (0.1), A. Wayne (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 understand their current distribution, promote their protection and conservation, 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 (2008/09) and main findings*

- Surveys almost completed for southern forests, although some gaps in survey area need to be filled.
- Surveys have been conducted in some areas of the northern jarrah forest and surveys of large

areas in northern jarrah forest have commenced.

- The commencement of a PhD study into the ecology and management of the quokka in southern forests.
- A total of 2031 sites have been inspected for presence of quokka from Mundaring in the north to Walpole in the south and quokka activity was found in 918 or 45.4% of these sites.
- Pigs were found to be active in 283 or 13.9% of these 2031 sites.

*Management implications*

Application of interim guidelines for fire management to protect and/or regenerate quokka habitat. This work will be superceded by a more objective assessment method of quokka abundance being developed by Karlene Bain as part of a PhD project.

*Future Directions (next 12-18 months).*

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

## Monitoring selected vertebrate communities in the Perup Nature Reserve

SPP# 1997/009

*Team members*

G Liddelow (0.1), B Ward (0.1).

*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 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 penicillata*) 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 (2008/09) and main findings*

This moniotirng program detected an alarming decline in woylie populations, which led to closer investigation into the cause of decline. Consequently this project has been suspended while the more detailed study into woylie declines in the Upper Warren is underway.

*Management implications*

Understanding the reasons for this rapid population decline will give insights into sustainable fauna conservation management. There is a need to improve techniques for assessment of activity of introduced predators and this will have implications for broader Western Shield baiting and monitoring.

*Future directions (next 12-18 months)*

See above.

## Assessing the distribution and status of the wambenger

SPP# 2003/11

*Team members*

N Marlow (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.

*Aims*

To determine if significant recent changes in distribution of wambengers have occurred.

*Summary of progress (2008/09) and main findings*

No work has been done on this SPP during the 2008/09 year.

*Management implications*

None.

*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.

## Probait trials: phase 2

SPP# 2000/014 (incorporates SPP# 1999/018)

*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.

*Aims*

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

*Summary of progress (2008/09) and main findings*

No work has been done on this SPP during the 2008/09 year.

*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.

## 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).

*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 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).

*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 (2008/09) and main findings*

- Trapping of woylies is ongoing and nearly 200 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 monitored in Tutanning (75 plots), Dryandra (129 plots) Highbury block (unbaited 31 plots) and Quinns block (unbaited 32 plots). Results indicate foxes are present in all sites despite repeated baiting in Dryandra Woodland and Tutanning Nature Reserve.
- Bait uptake (DMBs) by foxes and non-target species has been investigated using remote cameras. Bait uptake by possums and birds is extremely high and may preclude foxes from finding baits. Even at a simulated baiting rate of 50 baits per square kilometre, most baits are removed within 72 hours. The baiting regime in the northern half of Dryandra Woodland has been increased in intensity and frequency. The 1080 loading of baits is being increased from 3mg to 4.5 mg. Fifty baits per square kilometre have been delivered in the northern half of Dryandra since November 2008. Western Shield monitoring of woylies in March 2009 revealed that trap success of woylies in Dryandra Woodland has increased but that in Tutanning Nature Reserve has remained unchanged.

*Management implications*

- The baiting regime at Dryandra Woodland needs to be maintained at 50 baits per square kilometre. The baiting regime at Tutanning needs to be increased to 50 baits per square kilometre.
- Woylies have been relisted on the threatened species list.

*Future directions (next 6 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.
- Conclude field work for this project in December 2009 unless funding is obtained to continue the project.

## Return to Dryandra

SPP# 2003/002

*Team members*

N Thomas (0.1), N Marlow (0.05).

*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 x 10 ha) 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.

*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 (2008/09) and main findings*

- Dalgytes and Boodies are breeding very well and more releases are needed in the near future to reduce overcrowding in the enclosures. A strong male bias of both species has been observed and this needs to be rectified.
- A release of Dalgytes to Lorna Glen was undertaken in 2008 and another is planned for 2009. Five male dalgytes are to be released into Dryandra Woodland in spring 2009.
- Sightings and capture of wild born Dalgytes within Dryandra Woodland proper indicate that they have established well, albeit in low numbers.
- Nine marl were trapped in the Return to Dryandra breeding facility and transferred to the Barna Mia viewing facility. Overcrowding of marl may have resulted and during the last monitoring at Barna Mia none were captured.
- Mala numbers within the Return to Dryandra facility have increased from 13 to 17.

*Management implications*

- New sites for the translocation of dalgytes and boodies need to be found to prevent overcrowding of the breeding facility. It is likely that translocations to Lorna Glen in September – December 2009 will assist with this.
- The male bias of boodies and bilbies needs to be addressed because it is desirable to have equal, or nearly equal, sex ratios for translocations.
- The increased baiting regime in the northern half of Dryandra (50 baits per square kilometre) needs to be maintained to ensure the success of any future boodie (or other) translocations.
- The ongoing future of the breeding facility needs to be considered by the Department, taking into account translocation proposals over the next few years.

*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.

## Implementation of the Recovery Plan for the chuditch (*Dasyurus geoffroii*)

SPP# 1993/053

*Team members*

K Morris (0.25), J Jackson (0.40).

*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.

*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 (2008/09) and main findings*

- Ongoing monitoring at key recovery/translocation sites of Lake Magenta, Julimar and Kalbarri.
- Chuditch population at Forrestania (Western Areas mine site) in Goldfields woodlands, monitored through an Honours project.
- Recovery plan revision continued but not completed after conservation status review concluded that chuditch should remain listed as Vulnerable.
- ARC linkage grant with University of NSW on Quoll genetics completed and results prepared for publication.

*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.
- Complete revision of Chuditch Recovery Plan.

## Management of overabundant marsupials – North Island tammar wallaby case study

SPP# to be 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).

*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 soil erosion.

*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).
- To determine whether 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 (2008/09) and main findings*

- No further field work undertaken.
- Contraceptive treatment significantly reduced breeding. Abrolhos tammar wallabies were also found to breed earlier than other populations and have low levels of genetic diversity, particularly the North Island population.
- Lethal cull continued by DEC Midwest staff, ca 600 tammar wallabies removed, another estimated 300 remain. This is a considerably larger population than initially estimated through mark-recapture studies.

*Management implications*

This work demonstrated the potential for Suprelorin implants to reduce the fertility of female tammar wallabies and to humanely reduce the populations of over abundant macropods on islands.

*Future direction (next 12-18 months)*

- Ongoing vegetation monitoring by DEC Midwest staff.
- Outstanding work includes completion of a report on the tammar wallaby cull by the DEC Midwest Region and ongoing monitoring of the vegetation exclusion quadrats established to monitor vegetation regeneration after culling.

## Monitoring of mammal populations on Barrow Island

SPP# 2000/012

*Team members*

K Morris (0.05), Pilbara Regional staff and AA Burbidge.

*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.

*Aims*

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 (2008/09) and main findings*

- Monitoring undertaken in October 2008, including disease screening.
- Paper on spotlighting results and rock-wallaby survey methods submitted to Australian Mammalogy.

*Management implications*

- Monitoring will provide baseline information on mammal abundance, and presence/absence of introduced mammal species on Barrow Island.
- Development of monitoring protocols for native mammals and detection of introduced species will be used in the Gorgon terrestrial monitoring program.

*Future directions (next 12-18 months)*

- This project has now been taken over by consultants for Chevron.
- Ongoing advice to Chevron regarding the terrestrial monitoring program and quarantine surveillance.

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## 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).

*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.

The 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 (2008/09) and main findings*

- Fox baiting regime modified to simultaneous ground and aerial baiting every three months. This resulted in a 50% reduction in fox activity at Lake Magenta.
- Ongoing 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.
- Eradicat cat bait uptake trails completed – high rate of consumption by foxes and chuditch.
- Successful trial of hair capture techniques undertaken at Dunn Rock.
- Project reviewed by external reviewers in November 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 of 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.

*Future directions*

- Undertake final trapping and sand pad assessments at Lake Magenta and Dunn Rock.
- Undertake quenda translocation to Lake Magenta as a test for more effective fox baiting regime.

## Rangelands Restoration – reintroduction of native mammals to Lorna Glen

SCP to be submitted and SPP# to be allocated

*Team members*

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

*Context*

Operation Rangelands Restoration 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.

*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 (2008/09) and main findings*

- Restocking translocations of ninu (bilby) and wayurta (brushtail possum) undertaken successfully to Lorna Glen.
- Mala reintroduced and intensively monitored for three months - all radio collared mala had died by three months, primarily by cat, varanid and bird of prey predation, and lack of food.
- A strategy was prepared to improve survivorship of predator naive species, this included the construction of a 600 ha soft release/acclimatisation compound.
- 2009 Progress Report prepared.

*Management implications*

Arid zone rangelands fauna reconstruction and conservation techniques developed by this project will have broad state and national application. The outcomes of the project will contribute to the management of DEC's rangeland properties and provide guidance for future fauna reconstruction, e.g Dirk Hartog Island. It will also demonstrate effective partnership models with traditional owners.

*Future directions (next 12-18 months)*

- Final restocking with bilbies and possums in August 2009.
- Complete compound construction in September 2009.
- Remove all feral cats, foxes and rabbits from the acclimatisation compound.
- Introduce mala, boodie and golden bandicoot into the acclimatisation compound in late 2009 or early 2010.
- PhD examining the factors affecting survivorship of translocated mammals to commence in January 2010 (J Dunlop).

## 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).

*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.

*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 (2008/09) and main findings*

- Woma python tracking at Shark Bay has been completed and data have been entered into a database in anticipation of analysis.

- Road-kills collected over the study have been examined for dietary and reproductive data.
- In a mark-recapture study of carpet pythons on Garden Island, the 1000$^{th}$ python has been captured and marked. About 25% of captures are previously marked animals providing some novel information on the longevity and growth rates of wild pythons.
- Collection of scale clips and liver samples for future genetics work on pythons.

*Management implications*

The Woma python is a poorly known species and identified as threatened in several jurisdictions. Data from this study indicates that the species spends long periods underground in burrows and so is difficult to detect by traditional survey techniques. It shows a strong reliance on vertebrate food especially the rabbit. No adults have been lost to predators, but two radio-telemetered pythons were run over on the Monkey Mia road. There is a need for education of the public to encourage them to take care when driving on country roads after dark to reduce the carnage of native fauna.

*Future directions (next 12-18 months)*

- Write up 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.
- Undertake further searches in the Northern Wheatbelt for extant Woma python populations by working with community groups and local media outlets.

## Implementation of the Lancelin Island Skink Recovery Plan

SPP# 1999/011

*Team members*

D Pearson (0.05), Jurien Bay staff – R Hartley (0.05).

*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.

*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 (2008/09) and main findings*

- The outcomes of a translocation of captive-bred skinks to Favorite Island was monitored in December and March.
- Although captures of all skinks were low due to dry conditions, Lancelin Island skinks were caught in proportionately high numbers and included unmarked juveniles and adults indicating that breeding and recruitment have been successful on the Island

*Management implications*

The successful translocation of Lancelin Island skinks to Favorite Island has reduced its vulnerability to a natural or anthropogenic disturbance that might occur threaten the Lancelin Island population. Continuing vigilance to manage tourism, prevent fires and avoid the introduction of exotic animals to either island is required.

*Future directions (next 12-18 months)*

- Ongoing monitoring of the Favorite Island population to assess the success of the translocation with increased trapping intensity.
- Periodic monitoring of the Lancelin Island population to assess population trends.

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

*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.
- Provide advice and assistance to DEC staff and other organisations carrying out translocations.

*Summary of progress (2008/09) and main findings*

- A draft recovery plan has been prepared and is awaiting distribution to stakeholders for comment.
- Surveys were conducted in Cape Range National Park and neighbouring Ningaloo Station with the Cape Conservation Group.
- Advice was provided to several mining companies and environmental consultants about populations of *P. rothschildi* in the Pilbara.
- Assisted with collection of genetic samples from Nabarlek and Short-eared Rock-wallabies for a PhD student for Adelaide Uni (Sally Potter).
- Rapid survey of further sites around the West Kimberley race of *P. lateralis.*
- Assistance with goat control operations in Kalbarri National Park, and the monitoring of goat exclosure plots.

*Management implications*

The recovery plan will allow the prioritisation of actions to improve the conservation status of rock-wallabies in WA and adjoining regions. It will also assist Aboriginal ranger and IPA groups to manage their wildlife and to seek funds to undertake conservation work.

*Future directions (next 12-18 months)*

- Circulate the draft Recovery Plan for comment and amendment.
- Write-up of papers on survey work in WA and SA.
- Work with the Pilbara region to continue feral animal control in the Calvert Ranges and survey for wallabies in other nearby hills.

## Impact of cane toads on biodiversity in the Kimberley

SPP# 2006/004

*Team member*

D Pearson (0.5), L Brown (1.0 contract) and B Stewart (0.6 casual).

*Context*

Cane toads arrived in Western Australia during the wet season and have penetrated to the edge of Lake Argyle. Knowledge of their impacts on the fauna has been largely based on anecdotal accounts of toads killing native predators. The project has been documenting the responses of naïve native predators to toads in the laboratory and in the field. This ARC-linkage program partners DEC with the University of Sydney, the Australian Reptile Park and the Department of Environment, Water, Heritage and the Arts.

*Aims*

- To determine the susceptibility of a range of vertebrate and invertebrate taxa to impacts of cane toads.
- 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 (2008/09) and main findings*

- Laboratory trials have been carried out to document the responses of a range of snakes, goannas, lizards and small mammal species to cane toads. This has led to some surprising results with a range of observed responses from rapid learning to avoid toads, flipping toads and eating the less toxic underbelly, while in some species a high proportion of individuals die.
- Frog survey sites radiating along sealed roads from Kununurra were sampled regularly during the wet season to record presence/ absence based on calling males.
- Ongoing benchmark monitoring of vertebrate communities at a number of sites around Kununurra was undertaken during the year.
- Preparation of a manuscript on predicting the impact of toads on endemic land snails based on laboratory trials and field observations.
- Support and assistance for other researchers working on cane toad impacts.

*Management implications*

The project has identified a number of species at risk from cane toads and many more that rapidly learn not to eat toads or show behavioural and evolutionary responses of avoidance. 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)*

- Development of a bait to teach naïve predators to avoid toads. This could be deployed in advance of the arrival of toads and so reduce the impact on predator populations.
- Resampling of frog survey sites at regular intervals during the 2009-10 wet season, including sites that are being invaded by cane toads will document their impact on the native frog fauna. Undertake pre-cane toad vertebrate and land snail surveys in reserves and other land tenures in the East Kimberley with DEC regional staff.
- Implantation of transmitters in some species of snakes and involvement of Kununurra community in their radio-tracking to determine how these predators cope with the arrival of toads.

## 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).

*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 utilisation 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 (2008/09) and main findings*

- In addition to previous surveys covering ~ 260,000 square kilometres, some 60 000 $km^2$ of the south Kimberley – Tanami Desert region were surveyed in June 2009. Data are still being analysed but early impressions are that camel density is low compared with some other parts of the state.

*Management implications*

- Project results will inform risk assessment of the threat posed by feral camels to biodiversity.
- Data provide a basis on which to devise cost effective and priority control programs including aerial culling operations.

*Future directions (next 12-18 months)*

- DEC will participate in the $19M Caring for our Country Feral Camel Project to reduce the feral camel population in targeted areas.
- Further research on the impacts of feral camels on the environment and biodiversity values is needed as a basis for risk assessment and justification of control programs.
- Futher research into safer, cost-effective survey techniques are needed in order to assess effectiveness of management control actions.

## Identifying the cause(s) of recent declines of woylies in south-west Western Australia

SPP# 2007/002

*Team Members*

A Wayne (0.8), C Ward (0.8), C Vellios (0.8), M Maxwell (0.8).

*Context*

The woylie (*Bettongia penicillata*) has declined by about 80% since 2001. The declines of affected populations in Western Australia and South Australia have been rapid (<95% per annum), substantial (>90% lost) and apparently biased toward the largest and most important populations. The declines are continuing in some areas and as yet there have been no clear signs of a sustained post decline recovery. Most of the remaining unaffected populations are small (<300 individuals), isolated and inherently vulnerable. The woylie was has been relisted as “fauna that is rare or is likely to become extinct” (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-west 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 (2008/09) and main findings*

- The Population Comparison Study (PCS) 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. Key associations with the declines include presence of *Toxoplasma*, prevalence and parasitemia levels of *Typanosoma penicillata*, poor skin and fur conditions, presence of feral cats and foxes.
- Spatiotemporal analysis of the declines in Perup indicate a very clear and strong pattern of expansion from a single point-source, spreading at 10 km/year slowing to 2.5 km/year – i.e. indicative of an agent of limited mobility.
- Keninup is the last remaining area in Perup to be affected by the declines and is being closely studied. Radio-telemetry and sand pad monitoring has provided additional evidence of the role of predation. Animal health and disease screening has been done with onsite assistance from Perth Zoo wildlife clinicians.
- There are four genetically distinct indigenous populations – Perup, Kingston, Dryandra and Tutanning. Batalling (a translocated population, sourced from Perup) also has unique alleles. (PhD, C Pacioni)
- Progress with collaborative disease investigations include; macropod herpes virus, encephalomyocarditis, and orbivirus (Phd, C Pacioni); the heamaparasite, *Theileria penicillata* (Honours, J Rong); enteric parasites (PhD, U Parkar); Toxoplasma (Phds, N Parameswarran and S Pan,); and ectoparasites (PhD, H Burmej).
- Predator profiles based on prey carcasses have been developed for feral cats and wedge-tailed eagles (Honours, P Rogers, UWA) – enabling more confident identification of predators/scavengers associated with woylie deaths.
- Woylie diet and food resources do not appear to be related to the woylie declines and provide valuable ecological information including the discovery of several truffle species (PhD, K Zosky, Murdoch University).
- The weight of available evidence indicates that the declines in the Upper Warrren are driven by mortality, principally by predation by feral cats of individuals probably made more vulnerable by some other factor – disease being the most likely.
- Funding has been made available by State Government to construct a predator-proof compound in the Perup forest in order to secure a woylie population.

*Management Implications*

- The risk of local extinction of some indigenous and important populations has increased significantly, which if not avoided will have serious implications for the long-term conservation of the species.
- Effective predator control for feral cats and foxes is critical for sustaining important woylie populations
- Wildlife diseases and the associated monitoring, risk assessment, management and hygiene protocols are important.
- The outcomes of this work is directly relevant to determining the causes of declines in other species that may be more difficult to study directly (e.g. ngwayir, wambenger, quokka, numbat, etc), managing species recoveries, introduced predator control and biodiversity conservation more broadly
- Fauna data management – database centralisation, up-to-date maintenance, data quality control etc. are 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 other native fauna.

*Future directions*

Publication of results to date, construction of a predator-proof compound, on-going monitirng.

## 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).

*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 SPP# 1997/007) that identified these two arboreal species as potentially the most susceptible medium-sized mammals to jarrah forest timber-harvesting.

*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 (2008/09) and main findings*

No progress on this project in 2008/09.

*Management Implications*

- 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.
- Knowledge of habitat selection and preferences will inform ecologically sustainable forest management practices including timber harvesting, fire management, and introduced predator control.
- Identification of key habitat and appropriate management and protection requirements for species recovery and maintenance of long-term viable populations will improve the conservation of the threatened ngwayir and the koomal.

*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.

## Conservation of Western Australian butterflies

SPP# 1993/022

*Team members*

M Williams (0.4), A Williams (0.1).

*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 organisations, it extends co-operative partnerships with the community.

*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.
- To develop survey techniques to accurately assess butterfly biodiversity and use these to assess the abundance and species richness of butterflies in remnant bushland areas.
- To 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 (2008/09) and main findings*

- Scientific papers published:
    - Assessing biodiversity of diurnal Lepidoptera in habitat fragments: testing the efficiency of strip transects.
    - Butterflies and day-flying moths in a fragmented urban landscape, south-west Western Australia: patterns of species richness.
    - Species–area functions revisited.
    - Notes on the life history of the western xenica *Geitoneura minyas*.
    - Three new food plants for the blue iris skipper *Mesodina cyanophracta* Lower.
- Scientific paper submitted – Habitat resources determine distribution patterns and abundance of butterflies and day-flying moths in a fragmented urban landscape, south-west Western Australia.
- Bush Book completed – Common Butterflies of the South-West.
- Arid bronze azure butterfly listed as critically endangered by TSSC.
- Report submitted to Native Vegetation Conservation branch on the likely effects of vegetation clearing on the arid bronze azure.
- Further surveys of endangered arid bronze azure completed.
- Ongoing advice to managers and Regional staff, DEC's Species and Communities Branch and DEC's Environmental Management Branch on impacts of proposed developments.

*Management implications*

- Knowledge provided on butterfly populations for the assessment of the impacts of proposed developments on conservation values of listed endangered invertebrates of the Wheatbelt and Swan Regions.
- 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)*

- Undertake ecological studies of two endangered species (arid bronze azure and graceful sun-moth) to provide basic information on their habitat requirements, distribution and conservation
- Undertake further searches in the Northern Wheatbelt for extant arid bronze azure populations using community groups and local media outlets
- Finalise PhD project on conservation of butterflies and day-active moths in urban habitat fragments.

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

SPP# 2004/001

*Team members*

A Wills (0.20).

*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.

*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 (2008/09) and main findings*

Field work was completed in 2007 and no activity was undertaken in 2008/09.

*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

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# FLORA CONSERVATION AND HERBARIUM

## Program Leader: Dr David Coates

Applied flora conservation research seeks to understand the factors and processes that are critical for the conservation of Western Australia's native plant diversity. Major objectives include ensuring the persistence of rare and threatened species, ameliorating key threats such as *Phytophthora* dieback and weeds, and improving understanding of genetic and ecological factors that are vital for the long-term viability of plant species. This research is aligned to the information needs of the Department of Environment and Conservation (DEC). Strong collaborative linkages exist with universities, cooperative research centres, CSIRO and other research institutions and the corporate sector.

The program also includes the WA Herbarium which houses the State collection of scientific specimens of plants, algae and fungi, which underpins their conservation. The herbarium is responsible for:

- Documenting and understanding the diversity of Western Australia's plants, algae and fungi.
- Maintaining a research and archive collection of specimens of all species in these groups from throughout their range in Western Australia.
- Helping the community, industry and researchers understand and identify plants, algae and fungi.
- Contributing to, supporting and servicing the research, conservation and decision-making activities of the government.
- Contributing to taxonomic research by Australia's and the world's scientific community.

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### 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); A Perkins (0.4); K Shepherd (0.1), R Butcher (0.1), J Wege (0.1), K Thiele (0.1).

*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.

*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 groups.
- To determine the hybrid status of *Eucalyptus stoataptera*.
- To determine the mating system in populations of *Grevillea curviloba*.
- To clarify the taxonomic status of *Platytheca* sp. Sabina, *Hakea* aff. *prostrata*, *Pityrodia* sp. Yilgarn, and *Stylidium bulbiferum* and associated taxa.

*Summary of progress (2008/09) and main findings*

- *E. microtheca* and *E. rostrata* – Collections from the known populations and appropriate outgroups have been assayed for genetic diversity with microsatellite markers and data is currently being analysed to determine genetic relationships among population groups.
- *P. pauciflora* – Analysis of AFLP genotypes for six populations of *P. pauciflora* from three geographic areas show genetic differentiation of the Boddington populations, while the Brookton and Narrogin populations are genetically similar. Morphological assessment of the two genetic groups is required to determine taxonomic status.
- *B. mimica* – Analysis of microsatellite genotypes for populations of *B. mimica* from three locations showed genetic differentiation of the Busselton population. The Busselton population was also highly clonal with only three genotypes present.
- Journal paper on *E. bennettiae* as a hybrid between *E. sporadica* and *E. lehmannii* has been published in Australian Journal of Botany.
- Review of Pleistocene refugia in southern Australia has been published in Quaternary Science Reviews.
- Review of the evolutionary history of the Australian arid zone biota has been published as an invited review in Molecular Ecology.
- Samples of *E. stoataptera* and its putative parent's *E. stoatei* and *E. teptaptera* have been assayed with microsatellite loci and the data are currently being analysed.
- Seed has been collected from populations of *Grevillea curviloba* and is being germinated for assay to determine mating system parameters.
- DNA has been extracted from 58 samples of *Platytheca* sp. Sabina, *Hakea* aff. *prostrata*, *Pityrodia* sp. Yilgarn, and *Stylidium bulbiferum* and associated taxa. Amplification and sequencing of 10 chloroplast and rDNA gene sequences is been trialed.

*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.
- Possible taxonomic revision is required for *P. pauciflora* and revised assessment of conservation status.
- Taxonomic revision and revised assessment of conservation status of *B. mimica* taxa is required.
- Clarification of the genetic relationships among populations of *P. pauciflora* has revealed the need for a morphological assessment and taxonomic reassessment of the species.
- 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.
- Clarification of taxonomic status of *Platytheca* sp. Sabina, *Hakea* aff. *prostrata*, *Pityrodia* sp. Yilgarn, and *Stylidium bulbiferum* and associated taxa will enable evaluation of conservation status and implementation of conservation actions if required.

*Future directions (next 12-18 months)*

- Analysis of mating system parameters will be determined for *G. curviloba*.
- 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.
- Sequencing of informative genes regions will be completed for *Platytheca* sp. Sabina, *Hakea* aff.

*prostrata*, *Pityrodia* sp. Yilgarn, and *Stylidium bulbiferum* and associated taxa. Data analysis to evaluate taxonomic status will be undertaken.

## Genetic and ecological viability of plant populations in remnant vegetation

SPP# 2002/001

*Team members*

D Coates (0.2), M Byrne (0.1), C Yates (0.2), T Llorens (0.6), S McArthur (0.3), H Nistleberger (1.0), N. Gibson (0.05).

*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.

*Aims*

- To identify and quantify the genetic and demographic factors that affects 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 maximise 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 (2008/09) and main findings*

- Significant genetic structure was evident in the *B. sphaerocarpa* study area between populations in the north east and south west despite a lack of any clear vegetative or geographic barriers. A pattern of isolation by distance was also observed in the larger group of populations in the south west suggesting limited gene flow.
- As with the previous studies on *C. quadrifidus* and *E, wandoo* there were fitness related small population effects with seedlings in small *B. sphaerocarpa* populations showing reduced fitness, in terms of growth compared to large populations.
- A primer note describing eight SSR loci for *B. sphaerocarpa* has been published in Molecular Ecology Resources.
- Pollen dispersal in a small population of *Calothamnus* sp Whicher that occurs in continuous vegetation is currently being analysed to determine whether vegetation connectivity influences pollen dispersal.
- Analysis of genetic data in 8 populations of *H. oldfieldii* shows moderate levels of genetic diversity

among populations. Preliminary analysis of paternity assignment in three populations shows high levels of outcrossing with some pollen dispersal among populations.

- Genetic diversity in 8 populations of *B. nivea* ssp. *uliginosa* is currently being assayed and will be compared to diversity in populations of the common subspecies *nivea*. Pollen dispersal in 2 populations of ssp. *uliginosa* is being assessed to determine population connectivity.

*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 one 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 prioritisation 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 maximise 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 maximised.
- 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)*

- Prepare draft papers on:
    - *B. sphaerocarpa* seed set/reproductive output studies.
    - *B. sphaerocarpa* genetic structure studies.
    - *B. sphaerocarpa* 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*.
- Complete assessment of genetic diversity in *H. oldfieldii* and *B. nivea* ssp. *Uliginosa* and of pollen dispersal and mating systems in *H. oldfieldii* and *B. nivea* ssp. *uliginosa.*
- Complete investigations of reproductive biology and demography in *H. oldfieldii* and *B. nivea* ssp. *uliginosa.*

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## 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), M. Millar (0.1), J Sampson (0.35).

*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.

*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

indicates 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 (2008/09) 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 near completion.
- Analysis of genetic diversity of stands of *Eucalyptus cupraea* showed high clonality with most clumps consisting of single genotypes. Analysis of mating system in seed crops showed variable levels of outcrossing that was not related to population size with high levels of correlated paternity indicating inbreeding. There was evidence of some pollen dispersal into clumps over 500m to 5 km. Some plants that had been misidentified as *E. cupraea* were determined
- Genetic analysis shows that the two subspecies of *Banksia ionthocarpa* have different reproductive systems as ssp. *ionthocarpa* reproduces sexually and ssp. *chrysophoenix* has a high degree of vegetative reproduction. Genotypic diversity in ssp. *chrysophoenix* is critically low as the populations are dominated by large clones and two of the four extant populations are monoclonal. The effective population sizes of ssp. *chrysophoenix* are grossly overestimated as clonal patches can cover large areas with large patches in the two multiclonal populations comprised of 60 or more ramets. Genetic differentiation is high among the two subspecies and greater between populations of ssp. *chrysophoenix* than between populations of ssp. *ionthocarpa*. Genetic diversity in the species is low overall compared to more widespread species and lower for ssp. *chrysophoenix* than for ssp. *ionthocarpa*. A draft paper on the genetic study is in preparation.

*Management implications*

- Assessment and genetic variation will inform prescriptions for the prevention of inbreeding and maintenance of genetic variation in small fragmented populations of rare and threatened plants.
- Knowledge of patterns of genetic variation and mating systems facilitate strategies for managing inbreeding and loss of genetic diversity during translocation programs.
- A range of stands of *E. cupraea* should be targeted for conservation given that most stands are single genotypes due to clonality, and only three genotypes occur in conservation reserves. The quality of seed crops is variable due to inbreeding through selfing and correlated paternity although some long distance pollen dispersal does occur. Care must be taken in identification of *E. cupraea* as it can easily be confused with *E. loxophleba.*
- Effective population sizes should be updated for *B. ionthocarpa* ssp. *chrysophoenix*. Recommendations for management include establishment of *ex situ* collections of the 16 ssp. *chrysophoenix* genotypes via vegetative propagation and implementation of translocation for ssp. *chrysophoenix* to establish all genets in two new populations in secure and threat free sites. The two monoclonal populations of ssp. *chrysophoenix* are threatened by weed invasion that should be controlled to maximise vegetative reproduction. A reintroduction - translocation program for ssp. *ionthocarpa* should be re-commenced utilising mixed seed material from both subpopulations to: significantly increase plant numbers in the translocation site on the Kalgan Plains Nature Reserve and augment plant numbers in the two populations

*Future directions (next 12-18 months)*

- Finalise paper on 'Population genetic structure and mating system variation in *Verticordia fimbrilepis ssp. Fimbrilepis*'.
- Complete temporal mating system data analysis on *Banksia cuneata*.
- Submit paper on clonality in *Banksia ionthocarpa*
- Submit for publication two papers on genetic structure and the impact of localised extinction on

genetic diversity levels in *Banksia brownii.*

## Assessment of genetic diversity, key population processes and evolutionary relationships in the banded ironstone formation endemic *Acacia woodmaniorum* and its close relatives

SPP# to be allocated

*Team members*

D Coates (0.1) MA Millar (0.7).

*Context*

*Acacia woodmaniorum* is a recently described species endemic to the Blue Hills banded ironstone ranges of the Midwest region. Known from ~ 29,000 plants and restricted to an area of about 40km$^2$, the species is gazetted as a Declared Rare Flora. The entire species distribution is currently covered by exploration mining leases hence potential impacts on population and species viability from proposed mining activities must be identified. This study investigates the detailed genetic structure within this species as a basis for estimating loss af genetic diversity due to potential impact from mining. Phylogenetic and phylogeographic relationships between this rare species and its more common close relatives will also be investigated to to better understand its origins, whether rarity is associated with habitat specialisation or historical circumstances and the origins of the unique banded ironstone flora.

*Aims*

To determine:

- Levels and partitioning of population genetic variation within *A. woodmaniorum.*
- Key population processes, such as mating and dispersal, that influence future levels and patterns of genetic variation.
- Evolutionary relationships and distinctness of *A. woodmaniorum* and its closest relatives.

*Summary of progress (2008/09) and main findings*

- Large and small scale and high throughput DNA extraction protocols have been established.
- Microsatellite libraries have been constructed by Genetic Identification Systems.
- Microsatellite primers are currently being screened for suitability and PCR conditions optimised.
- Field work comprising the bulk of initial germplasm sampling for *A. woodmaniorum* has been conducted.
- First six monthly report has been provided to Gindalbie Metals Ltd.

*Management implications*

Assessment of genetic diversity and mating system parameters will enable evaluation of the impacts of proposed mining developments on population maintenance and species viability of rare banded ironstone endemics, specifically *A. woodmaniorum*.

*Future directions (next 12-18 months)*

- Complete field work for initial germplasm collections and seed collections in *A. woodmaniorum* and for germplasm collections in related Acacia species.
- Genotype ~600 *A. woodmaniorum* samples at 10-15 polymorphic microsatellite loci for genetic diversity estimates.
- Genotype ~800 *A. woodmaniorum* seedlings at 6 polymorphic microsatellite loci for gene flow estimates.
- Data analysis.
- Identify DNA sequences of sufficient variation to provide phylogenetically informative data.
- Quantify pollinator visitation, pollination rates and seed production in all populations.
- Complete progress reports for Gindalbie Metals Ltd as required.

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

SPP# 1999/010

*Team members*

A Cochrane (0.8), A Crawford (0.9), A Monaghan (0.5), S Dudley (0.3), D Coates (0.05) .

*Context*

Seed conservation is a specific and targeted action to conserve biodiversity and entails the banking of genetic material in the form of seed. Seed banking provides an important opportunity for assessing and utilisating genetic material for in situ recovery actions, and seed research. Understanding the seed biology and ecology of plant species is important for the conservation and management of conservation-significant Western Australian taxa and for developing and implementing recovery plans for rare and threatened flora.

*Aims*

- To provide a cost effective and efficient interim solution to loss of plant 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 (2008/09) and main findings*

- Fieldwork undertaken to collect seed from 184 rare, threatened, poorly known and other taxa (216 accessions). This includes 59 DRF, 61 Priority and 96 general collections associated with threatened ecological communities and biodiversity hotspots, equating to 38 DRF taxa, 60 Priority taxa and 86 species other taxa of interest. All information is accessible in the seed database WASEED.
- Duplicate material of 195 collections sent to the Millennium Seed Bank Project in the UK for safe keeping.
- Final report provided to South Coast NRM Inc and the Australian Government on Project 033146a. State-wide seed conservation strategy for threatened species, threatened communities and biodiversity hotspots.
- Three popular articles written - A unique voyage for threatened plants - Two Peoples Bay Nature Reserve - The role of seed orchards in plant conservation.
- Two Peoples Bay Discovery Book published.
- Promotional brochure produced (Threatened Flora Seed Centre. Coordinated Plant Recovery: A vision for seed conservation and use in Western Australia)
- Paper presented to the Ecological Society of Australia annual conference in Sydney, Australia December 1-5, 2008 (Ecological fire management thresholds for conserving *Banksia* species in a climate-threatened ecosystem in southern Western Australia).
- Co-author on scientific paper (An extinction risk assessment tool for flora threatened by *Phytophthora cinnamomi*).

*Management implications*

Improved conservation of threatened and endemic WA flora will be enabled by greater understanding of their seed biology and ecology.

*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.
- Complete Phase 2 of international collaboration with Millennium Seed Bank (MSB) Project and provide final report to MSB.

## Translocation of Critically Endangered plants

SPP# 2001/004

*Team members*

L Monks (0.6), R. Dillon (1.0), D Coates (0.05).

*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.

*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 (2008/09) and main findings*

- Translocations of nine Critically Endangered plants were completed as part of stage three of the Biodiversity Conservation Initiative (BCI). This involved the establishment of new populations for three new species and infill planting at seven sites established as part of stage one and two of the BCI project.
- Seven translocations planted in previous years were monitored. Infill plantings were undertaken at two of these sites.
- 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 utilised immediately in other flora translocation projects.
- Ongoing development of flora translocation database continuing in collaboration with Species and Communities Branch.
- Completed draft paper of study on *Lambertia orbifolia* translocation success, commenced writing paper on Acacia translocation success.

*Management implications*

- Translocations lead to improved conservation status for critically endangered plant taxa.
- Improved awareness of best practice translocation methodologies for DEC staff and communities members undertaking such work will lead to greater translocation success.

*Future directions (next 12-18 months)*

- Commence stage four of the Threatened Plant Translocation project as part of the Biodiversity Conservation 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, *Acacia* translocation success study and book chapter on translocation success for long lived plants.

## Ecophysiology of rare flora restricted to shallow-soil communities

SPP# to be allocated

*Team members*

P Poot (0.5).

*Context*

The south-west Australian floristic region is recognised 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 s-w 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.

*Aims*

This project aims to enhance our knowledge of the key adaptations of species endemic to shallow-soil habitats, and how these adaptations may restrict them in their distribution. This knowledge will help improve our ability to manage and restore shallow-soil ecosystems and the many rare species they contain.

*Summary of progress (2008/09) and main findings*

- Glasshouse experiments with varying light and P-nutrition levels have shown that rare ironstone *Hakea* species have a lower phenotypic plasticity then their common congeners in several key characteristics: (1) they were unable to down regulate their photosynthetic machinery at low light levels, and (2) they hardly changed their vertical root allocation pattern in response to different P levels. Both observations may help explain these species limited success in deeper soil habitats.
- Glasshouse experiments on ironstone soil have shown that the growth rates of the common non-ironstone *Hakea* species is more severely affected by waterlogging then that of the ironstone endemics. Also, both ironstone endemics had inherently higher levels of leaf Cu and Zn which may be related to their waterlogging and drought tolerance (potentially high superoxide dismutase activity). The results of this work were published in the Australian Journal of Botany.
- Preliminary results with 'granite outcrop/non-granite outcrop' congeneric species pairs showed similar shallow-soil specialisations: 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.
- Currently a fourth year student at UWA is investigating the root responses of ironstone endemics and their common congeners to nutrient and moisture patches.

*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 ratios.
- 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 a water supply.

*Future directions (next 12-18 months)*

- Continue research on shallow-soil endemics (through UWA Honours and PhD students).
- Write up and submit (1) the ironstone species work on phenotypic plasticity and (2) the work on granite outcrop species.
- 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.

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

SPP# 1993/068

*Team members*

B Shearer (0.5), C Crane (0.5) .

*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.

*Aims*

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

*Summary of progress (2008/09) and main findings*

Published four papers in Forest Pathology, Plant Pathology and Australasian Plant Pathology.

*Management implications*

Effective methods of *P. cinnamomi* control using phosphite will provide options for the management of dieback infections.

*Future directions (next 12-18 months)*

Prepare results of injection and spray trials for publication.

## Susceptibility of rare and endangered flora to *Phytophthora*

SPP# 1999/019

*Team members*

B Shearer (0.5), C Crane (0.5) .

*Context*

Determination of the susceptibility of threatened flora to *Phytophthora cinnamomi* is important for prioritising 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.

*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 (2008/09) and main findings*

- Tested 80 taxa for susceptibility in 2009.
- To date 50+ taxa transferred to pots for testing in 2010.
- Database of 200 + taxa updated.
- Provisional susceptibility list distributed within DEC.
- Published paper – An extinction-risk assessment tool for flora threatened by *Phytophthora cinnamomi.*

*Management implications*

Identification of flora at risk of infection by *P. cinnamomi* will enable quantification of the threat of *P. cinnamomi* to flora conservation.

*Future directions (next 12-18 months)*

- Plant up germinants as received from Threatened Species Seed unit throughout 2009.
- Inoculate plants in 2010 and record mortality.
- Update database.
- Test survivors for root infection.
- Prepare for publication variation in susceptibility within *Lambertia* species to *Phytophthora cinnamomi.*

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## An investigation of the epidemiology and use of novel phosphite application techniques in *Phytophthora cinnamomi* infestations in the national parks of the south coast region of Western Australia

SPP# 2009/007

*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.

*Aims*

- To advance our understanding of disease biology and epidemiology of *P. 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 *P. 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 (2008/09) and main findings*

- Ongoing monitoring of spatial variation in the soil population dynamics of *P. cinnamomi*.
- The root structure of susceptible native plant communities was investigated by air spading near the Bell Track infestation in the Fitzgerald River National Park. A high degree of root connectivity was observed between different plant species and root systems were clustered in areas of higher soil moisture. On the basis of measurements of lateral root spread from the base of the dominant overstorey species, a minimum buffer of 10 m is recommended for hygiene management in this native plant community.
- The distribution of the pathogen was determined through the soil profile at three locations across the South Coast of WA. The pathogen can be isolated from the top 3 cm of soil down to soil depths greater than 1 m. There appears to be a concentration in the top 40-60 cm of the soil profile.

- On-going monitoring of the efficacy of the High Intensity Phosphite application at three locations in the South Coast region.
- Investigation of the nature of surviving susceptible plant species in infested areas is now complete. The aim of the project was to determine if the surviving *B. coccinea*, a highly susceptible plant species, within the infested area are disease escapes or have a greater level of genetic resistance. A range of responses were observed with some anecdotal evidence that a greater proportion of plants within the infested area have some tolerance of the pathogen. Further statistical analysis is required to elucidate the nature of any significant relationships.

*Management implications*

- Improved efficacy of phosphite treatment to control *P. cinnamomi* means this technique is now being used at the Bell Track infestation in the Fitzgerald River National Park to contain the pathogen to its current micro-catchment.
- Increased understanding of disease epidemiology will allow for more accurate modelling of disease centre extension.
- Improved management of *P. cinnamomi* through the use of appropriate hygiene practices will prevent further spread of infections.
- Improved field diagnostics for determining the presence and absence of the pathogen in soil and plant tissue samples will enable greater accuracy in identification of infections.

*Future directions (next 12-18 months)*

- Monitoring the spatial variation in the soil population dynamics of *P. cinnamomi* for another 12 months.
- Monitor the efficacy of high intensity phosphite to prevent disease centre extension and minimise the impact of *P. cinnamomi*.
- Investigation into the efficacy of phosphite in controlling newly described *Phytophthora* species from the south-west of WA.
- Investigate the potential to eradicate spot infestations of *P. cinnamomi* on the South Coast of WA.
- Publish the research findings on the "Seasonality of *P. cinnamomi* from the South Coast of WA".
- Publish a technical paper on the "Last Stand at Bell Track" project.

## 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 elite 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.

*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 (2008/09) and main findings*

No progress on this SPP in 2008/09.

*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 is being 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 the focused selection and cloning of additional resistant lines to maintain the required level of genetic diversity in the orchard in the long-term.

## 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*. Seedling DRJ are now available for operational plantings as the DRJ seed orchard 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 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.

*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 maximising the survival of seedlings planted in dieback graveyard sites.

*Summary of progress (2008/09) and main findings*

No progress on this SPP in 2008/09.

*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 on the results of site treatments tested in the field trials will be submitted for publication.
- The project is being maintained with a low level of activity. The field trials will be retained for long-term monitoring.

## Mundulla Yellows disease in Western Australia

SPP# to be 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.

*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 (2008/09) 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). Newly observed MY-affected sites have been checked and sampled, including several reported by DEC staff. Spread of MY symptoms at any given site does not appear to be rapid, and diseased and apparently-healthy trees can grow alongside each other. Affected trees have still not been observed within undisturbed forest or woodland stands.
- Seedlings are being grown on in the glasshouse for testing in transmission trials.
- A conference paper was presented 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) set up by the Natural Resource Policies and Programs Committee (NRPPC) [formerly the LWBC] of the Natural Resource Management Ministerial Council 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)*

- Continue 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.
- Continue collaboration with, and assistance to, Dr Hanold and the Adelaide researchers.

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## Vegetation Health Service

Core Function

*Team members*

M Stukely (0.25), J Webster (0.6), J Ciampini (0.4).

*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.

*Aims*

- To provide a dedicated 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 as well as providing a service which is 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 and other native ecosystems, plantations and nurseries.

*Summary of progress (2008/09) and main findings*

- A total of 1789 samples were processed for *Phytophthora*, and all isolates of *Phytophthora* spp. (other than *P. cinnamomi*) were subcultured for identification to species.
- DNA sequencing of new *Phytophthora* isolates, as well as historical isolates from the VHS culture collection, has shown that at least nine new and undescribed *Phytophthora* taxa (designated *P*. spp. 1-11) are established in WA's natural ecosystems. They are all associated with dying native plants. They have not been reported from elsewhere, to date.
- New records for WA were confirmed (among VHS isolates) for five additional *Phytophthora* taxa that are known from elsewhere.
- A journal paper on all of the newly recorded *Phytophthora* taxa was published in Plant Disease.
- A paper on the putative new *Phytophthora* taxa was presented (by Dr T Burgess, CPSM) at 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.
- DNA sequencing of VHS isolates by Dr T Burgess has provided strong new evidence that several unique, hybrid Phytophthora's exist in WA native ecosystems.
- The formal description of *Phytophthora multivora* (formerly designated *P*.sp.4), the first new *Phytophthora* described from Australian native ecosystems, was published in Persoonia.
- Journal papers reporting *P. lateriticola* and another of the undescribed taxa (*P*.sp.1) are in

preparation for publication.

- 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 presentation 'New *Phytophthora* species in WA.' was given at the 2008 *Dieback Information Group (DIG) Conference.*

*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 Murdoch University Centre for *Phytophthora* Science and Management (CPSM) 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 had 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.
- The existence of putative *Phytophthora* hybrids associated with dying plants in WA native ecosystems, in addition to the new taxa, adds a new dimension to *Phytophthora* management.
- 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.
- The VHS facilities and culture collection will continue to be available for use by CPSM 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*.
- Continue collaborative work with CPSM on the recently isolated *Phytophthora* spp. nov., and on the putative *Phytophthora* hybrids.
- The draft recommendations 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.

## The population ecology of Critically Endangered flora

SPP# 2000/015

*Team Member*

C Yates (0.1) .

*Context*

South-west Western Australia is a global hotspot of plant diversity. Determining the relative importance of multiple threatening processes including 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.

*Aims*

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 (2008/09) and main findings*

- Continued monitoring the effect of fire interval on plant species richness and abundance in the Critically Endangered Eastern Stirling Range Montane Heath and Thicket community.
- Continued monitoring the demography of DRF and other taxa of conservation significance in the Critically Endangered Eastern Stirling Range Montane Heath and Thicket community.
- Completed supervision of student honours 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. Completed journal manuscript (in review).
- Published manuscript "Defining plant functional groups to guide rare plant management" in the scientific journal Plant Ecology.

*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.

*Future directions (next 12-18 months)*

Continue to monitor the fire ecology of the Eastern Stirling Range Montane Heath and Thicket Community.

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

SPP# 2000/015

*Team members*

C Yates (0.1), N Gibson (0.1).

*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, *T. paynterae* ssp. *cremnobata* found on the Diehardy Range; *T. harperi* found on the Mount Jackson Ranges; and, *T. aphylla* found at the Helena and Aurora Ranges. The project is investigating the environment, reproductive biology and demography of the ironstone *Tetratheca* taxa.

*Aims*

- Describe and compare the physical environmental domains of the four banded ironstone Formation (BIF) *Tetratheca* taxa and associated floristic assemblages to assist with identifying sites and techniques for translocation.
- Describe and compare the reproductive biology of the four BIF *Tetratheca* taxa and investigate how reproduction is influenced by climate.
- Describe and compare the population structures and demography of the four BIF *Tetratheca* taxa and estimate annual rates of demographic parameters.
- 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 (2009/09) and main findings*

Project completed and final report submitted 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 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.
- Further reducing the size of the *T. paynterae* subsp. *paynterae* population will reduce the viability of the population.

*Future directions (next 12-18 months)*

Submit manuscript to refereed scientific journal.

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

SPP# to be allocated

*Team member*

G Keighery (0.1).

*Context*

Many Declared Rare Flora (DRF) have nomenclatural and taxonomic issues that require resolution for their conservation and management. Many new taxa are routinely uncovered during biological survey.

*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 surveys 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 naturalised species in *xalis 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 (2008/09) and main findings*

- New *Bossiaea* confined to the Coomberdale Cherts separated and described. Paper describing newly segregated *Bossiaea* in press.
- Paper describing new highly restricted *Grevillea* from Gillingarra in press.
- A paper describing the six DRF *Darwinia* species with phrase names published.
- 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.
- The widespread weed *O. corniculata* was 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* to be published.
- Taxonomic notes on *Adenanthos pungens* to be published.
- Taxonomy notes on *Calytrix breviseta* drafted and in press.
- Taxonomic notes on *Cynoglossum* in press
- New rare subspecies of *Grevillea brachystylis* to be published.

## 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.

*Aims*

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 utilisation .

*Summary of progress (2008/09) and main findings*

- Paper published describing 10 new species and two new subspecies from the Pilbara.
- Descriptions, distribution maps and photographs assembled for all Pilbara taxa summarising relevant information on morphology, biology, ecology, distribution, utilisation 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 was completed and has been tested by a number of competent users. This key will accompany 'Guide to Wattles of the Pilbara' and is also to be published on WorldWideWattle website.
- Bush Book published (2008) in which 32 Pilbara taxa are described.

*Management implications*

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

*Future directions (next 12-18 months)*

Complete and publish 'Guide to Wattles of the Pilbara' with accompanying CD identification key.

## Conservation status and systematics of Western Australia *Acacia*

SPP# 2003/008

*Team members*

B Maslin (0.3), J Reid (0.1).

*Context*

*Acacia* species are coming under increasing consideration for utilisation 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 utilisation is to be sustainable

and their conservation effective.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- *Acacia saligna*: taxonomic revision of *A. saligna* is being prepared for publication.
- Curation of Herbarium *Acacia* collections ongoing (as basis for re-assessment of conservation status of the WA taxa).
- Revision of *A. verniciflua* group completed and submitted for publication (with D Murphy).

*Management implications*

Identification of *Acacia* species with agroforestry potential that will provide options for revegetation programs.

*Future directions (next 12-18 months)*

- Complete write-up of *A. microbotrya* project.
- Continue reassessment of conservation status of WA *Acacia* flora.

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## 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.

*Aims*

- 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 (2008/09) and main findings*

- WorldWideWattle website developed and is being maintained.
- Attended meetings in connection with the Environmental Interpretive Centre in Dalwallinu.
- Report on human food potential of Dalwallinu Wattles prepared for Dalwallinu Shire.

*Management implications*

Greater understanding of *Acacia* species will enable more effective community engagement in their 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.

## Understanding Mulga

SPP# to be 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).

*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 utilisation of this valuable resource.

*Aims*

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 utilised.

*Summary of progress (2008/09) and main findings*

- Field studies undertaken in Murchison, Ashburton and Pilbara districts of W.A. and selected localities in N.T. and S.A. to collect material for taxonomic and genetic study, and seed for ontogenetic study (2008 and 2009).
- DNA extracted for 2008 and 2009 collections and sent to Miller for analysis.
- cDNA and microsatellite results analyses continuing.
- Taxonomic sort of the herbarium collections continuing.
- Seed from 2007 and 2008 field study germinated and seedling growth characters scored; 2006 seedlings transplanted at Curtin University.
- Sponsors Workshop relating to Understanding Mulga project conducted.
- Anatomical examination of selected Mulga pods undertaken (by Rutishauser).
- Mulga gum submitted to Government Chemical Laboratory for analysis.

*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 Pilbara to acquire additional material for taxonomic, genetic, anatomical and ontogenetic studies.
- Continue genetic sequencing based on DNA extracted.
- Continue scrutiny of collections and to relate taxa thus recognised to groups defined by the genetic and other studies.
- Progress ontogenetic and anatomical study.
- Transplant seedlings in WA Herbarium glasshouse to Mulga plots at Curtin University.

## 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) .

*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 utilisation. Other plant groups under study have also been chosen from amongst the Western Australian taxa most in need of taxonomic review.

*Aims*

- 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 (2008/09) and main findings*

- Interactive key to members of the Myrtaceae tribe Chamelaucieae now includes over 765 taxa and over 150 characters.
- 1 paper has been published and two are currently in press. A paper on *Petrophile* has been submitted for the following issue of *Nuytsia*.
- 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*

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.
- Submit papers for a special issue of Nuytsia on Myrtaceae tribe Chamelaucieae.
- Conduct field studies on poorly collected and taxonomically difficult species groups.
- Prepare two papers on *Isopogon*.

## Taxonomic resolution and description of new plant species particularly Priority Flora from those areas subject to mining in Western Australia

SPP# 2009/006

*Team Members.*

R Butcher (0.9), K Shepherd (0.9), J Wege (0.9), C Wilkins (0.5)

*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 1,525 putatively new and undescribed taxa in Western Australia, a significant proportion (35%) 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.

*Aims*

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.

*Summary of progress (2008/09) and main findings*

- Ten taxonomic manuscripts (*Dysphania, Guichenotia*, *Platytheca*, *Pultenaea*, *Stylidium*, *Tecticornia*, *Tetratheca*) were published in *Nuytsia* volumes 18 and 19(1) and a further five papers (*Eutaxia*, *Hakea*, *Hibbertia*, *Marianthus*, *Petrophile*) were submitted for publication.
- 10 taxa were added to the *Declared Rare and Priority Flora List for Western Australia*, with *Hibbertia* sp. Bandalup Hill (G.F. Craig 3479) nominated for listing as Declared Rare Flora.
- An improved taxonomic understanding of a number of species complexes within *Bossiaea*, *Platytheca*, *Stylidium*, *Synaphea* and *Tecticornia* was achieved.
- 23 phrase-names were added to Western Australia's plant census as a result of taxonomic assessment.
- Descriptive data for *c*.80 geographically restricted and/or poorly known species from the Ravensthorpe region have been compiled.
- Field studies have resulted in the acquisition of *c*.180 herbarium specimens for the State collection.
- Team members collectively provided expert determinations for 3630 specimens at the Western Australian Herbarium. Collections at the National Herbarium of Victoria, South Australian Herbarium and Tasmanian Herbarium were examined and improved during visits to these institutions.
- Three presentations were given at the 2008 Australian Systematic Botany Society conference in Adelaide.

*Management Implications*

The provision of names, scientific descriptions, illustrations and associated data for a range of new species will enhance the capacity of conservation and industry personnel to identify these taxa, thereby improving conservation assessments and effective management.

*Future Directions (next 12-18 months)*

- Assess and formalise the taxonomy of new Western Australian plant taxa, particularly those of conservation significance.
- Conduct field studies on poorly collected and taxonomically difficult species groups.
- Add and remove taxa from the Western Australian Plant Census, as required; and make recommendations regarding the appropriate conservation listing of Western Australian plant taxa.

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

SPP# to be allocated

*Team members*

A Chapman (0.1), M Hislop (0.1).

*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.

*Aims*

- To publish in *Nuytsia* the taxa new to science in these genera.
- To revise generic concepts in line with recent systematic studies.
- To score in detail the descriptive data for the species in each genus.
- To publish one or more interactive keys on FloraBase.

*Summary of progress (2008/09) and main findings*

- Research into the relationships of WA *Monotoca* and *Oligarrhena* based on morphological and molecular evidence completed, and a joint paper with workers from the NT and Queensland drafted.
- Two papers publishing six new species of *Leucopogon* published in the journal *Nuytsia*.
- Continued collaboration on generic concepts with specialists in other genera within the tribe *Styphelieae*, and involving the WA Herbarium, Edith Cowan and James Cook Universities.
- Collection and re-determination of *Leucopogon* and *Monotoca* specimens in the WA Herbarium, 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 Western Australia. 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 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)*

- Publication of paper describing *Monotoca aristata* ms and its systematic placement.
- Publication of a collaborative paper revising the relationships of WA *Monotoca* and *Oligarrhena* based on morphological and molecular evidence.
- Further papers describing new taxa in *Leucopogon* prepared for publication.
- Critically examine and score key morphological characters for descriptions, keys to 20 taxa.
- Publish detailed WA *Leucopogon* species descriptions in FloraBase.

## Taxonomy of selected families including legumes, grasses and lilies

SCP# 2007/013 (SPP# to be allocated)

*Team members*

T Macfarlane (0.7), R Cranfield (0.4) .

*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.

*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 (2008/09) and main findings*

- *Wurmbea* (Colchicaceae): field work continued in the Midwest and Murchison regions, clarifying the taxonomy of *W. densiflora* and *W. inframediana* groups; discovery of two new species; drafting of articles including a summary of the taxonomy of the genus in WA.
- *Hydatellaceae*: field work in Manjimup area showed the recently named *Trithuria austinensis* is relatively secure in the region, occurring in a number of wetlands with varying vegetation cover and water salinity, but is absent from some where it was expected; advised on pollination studies by a United States researcher which are continuing; advised on management plan for the threatened species *Trithuria occidentalis* and the conservation status of *T. australis*.
- *Austrodanthonia* (Poaceae): fieldwork confirmed that an anomalous specimen from a swamp near Manjimup is a previously unrecognised species, and the range of an unnamed wheatbelt species was extended substantially southward and its ecology better understood.
- *Neurachne* (Poaceae): a supposed Queensland record of the genus allied to the Yilgarn species *N. annularis* described recently, when examined, turned out to belong to a presumed unnamed genus; the relationships were examined and a description prepared in collaboration with Queensland and US researchers, and DNA studies are now underway.
- *Corynephorus* (Poaceae): an anomalous herbarium specimen collected in WA was found to be a newly recorded introduction of this genus into Australia, and a description was published. Field work was also conducted at the collection site in the Wheatbelt in an attempt to assess the population parameters.
- *Thysanotus*: supervision of a research student continued; a paper was submitted describing a new species from the southern forests; fieldwork in the Midwest, Wheatbelt and South Coast regions secured a number of samples for DNA studies which have since been analysed; two further papers have been drafted.
- *Pultenaea* (Papilionaceae): field work was carried out aimed at a taxonomic review of the threatened species *P. pauciflora*.
- *Baeckea* group (Myrtaceae): contributed to revision of the taxonomy, description of new genera and species, nomination of species for consideration of threatened status as required, and provision of means for identifying the plants of this large plant group.
- Quarram grasslands: provided training and guide materials to field staff on recognition of the grass flora of the area.
- Biological survey, Charles Darwin Reserve: participated as botanist in a national pilot study of reserve surveys, identified collections and submitted preliminary report.
- Presentation on grass taxonomy in relation to pollen allergens to Australasian Society of Clinical Immunology and Allergy (WA).
- *Leptospermum spinescens* (Myrtaceae): this variable species which has particular variation in the Ravensthorpe Range has been re-visited and the draft paper revised.
- *Brachyloma* (Epacridaceae): draft paper revising the genus is undergoing editing.
- FORESTCHECK project: surveyed field plots, collected, identified and reported on cryptogams including a chapter of the overall annual report and presentation at the annual FORESTCHECK research meeting; assisted with field survey identifications and reporting of vascular plants.

*Management implications*

- The conservation status was clarified for several species, including one that is critically endangered, with the new information included in submissions to the Threatened Species Scientific Committee.
- Threats to nature reserves from weedy grasses were observed in the field and a draft report prepared with management recommendations.
- Discovery and detailed surveying of species in *Wurmbea* and other groups contribute to identification of conservation values of reserves, particularly in the rangelands, and point to the

existence of geographically restricted as well as the better known widespread species.

- Taxonomic and conservation status clarified for *Leptospermum spinescens* group populations in the Ravensthorpe Range.
- Lichen and plant inventories for FORESTCHECK contribute to the forest management aims of that overall project.

*Future directions (next 12-18 months)*

- Complete and submit draft papers on *Wurmbea*, *Thysanotus*, *Austrodanthonia.* Complete final report on Charles Darwin Reserve survey.
- Continue to revise plant groups and investigate via field and herbarium studies various putatively new species in order to improve knowledge of the flora, provide stable plant names and provide means of identifying species.

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## Taxonomic studies in selected families, including Asteraceae, Celastraceae Malvaceae, Proteaceae

SCP# 2008/001 (SPP# to be allocated)

*Team member*

N Lander (0.9).

*Context*

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

In connection with the Biodiversity Conservation Initiative (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.

*Aims*

- To revise genus *Olearia* in Australia.
- To resolve species in Asteraceae, Celastraceae, Malvaceae.
- To publish in Nuytsia and other suitable journals 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 (2008/09) and main findings*

- Papers published:
    - Elucidation of *Olearia* species related to *O. paucidentata* (Asteraceae: Astereae).
    - New species of *Olearia* (Asteraceae: Astereae) from Western Australia.

- 346 comprehensive *Grevillea* species descriptions published FloraBase. (Interactive key to WA *Grevillea* Species, previously ported to Lucid and submitted, awaits publication.)
- Interactive key to WA Asteraceae Genera (183 genera) with binary keys to species within most genera completed.
- e-Genera. Major revision of data base undertaken, ~two-thirds complete (109 of 188 genera).

*Management implications*

- The Asteraceae have a major centre of diversity in WA, with over 570 species (in 183 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 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. In south-west Western Australia some members of this family are common indicator species for the presence of dieback, and it is the family with the highest number of listed species affected.

*Future directions (next 12-18 months)*

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

## 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).

*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 (2008/09) and main findings*

- 21 447 specimens were added to the collection, which now stands at 794 686, a 3.1 % increase during the year.
- The major plant groups in the collection are as follows:

| Taxonomic Group | Number of specimens (June 2009) | Increase since June 2008 | |
|---|---|---|---|
| | | Number | % |
| Myxomycetes | 653 | 63 | 10 |
| Fungi | 20 440 | 526* | 2.5 |
| Lichens | 15 402 | 225 | 1.4 |
| Algae | 22 345 | 157 | 0.7 |
| Liverwort & Hornworts | 1 882 | 6 | 0.3 |
| Mosses | 6 435 | 27 | 0.4 |
| Ferns and fern allies | 3 502 | 74 | 2.1 |
| Gymnosperms | 1 974 | 29 | 1.5 |
| Flowering Plants | 632 053 | 20 340 | 3.3 |
| Total number | 704 686 | 21 347 | 3.1 |

- Significant curatorial work was accomplished in the genera *Eucalyptus*, *Jacksonia*, *Gompholobium*, *Acacia* and *Tecticornia.*
- Scanning a representative sample of all Priority and DRF taxa for reference as requested by DEC regional staff and other stakeholders.
- Declared Rare Flora taxa curated, see under WACensus and WAHerb.
- Updating the collections systematic sequence according to the new linear Angiosperm Phylogeny Group (APGIII) findings.
- Significant collections added to the Herbarium holdings came from Yilgarn Ranges Survey, Woodland Watch, Mulga Project, Meekatharra Dept. Ag. & Food closure specimens, Pilbara Regional Herbarium, Threatened Flora Seed Centre vouchers, Kings Park, DEC Regional Offices and Regional Herbaria and a range of Environmental Consultancies.
- Loans and exchange:
    - Loans outward – 2142 specimens.
    - Loans inward - 1691 specimens (including images on CD)
    - Exchange outward – 2471 specimens.
    - Exchange inward - 740 specimens
- Volunteer participation was significant, totaling approx. 11 000 hours (equivalent to 6.0 full-time positions).
- Tasks managed by curation staff with the assistance of volunteers were as follows:
    - Mounting 15290 specimens.
    - General curation of specimens, and incorporation of specimens into the collection.
    - Maintaining and adding specimens to the Reference Herbarium collection.
    - Validating doubtful location outliers, and auditing the collection.
- 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*.
- Maintained and increased the number of taxa represented in the Reference Herbarium which currently has 14207 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 and new herbarium building 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.

## 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) .

*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 (APC) 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 250 plant families, constituting well over half of the plant names in Australia. In the past year the project has extended from dealing with genera and species to an updated and consensus modern family classification, with almost all of the Flowering Plant families reviewed with only the other vascular plant groups including gymnosperms and ferns still to be circulated for review. The Western Australian Herbarium is providing substantial input into the APC project through an APC Working Group. As the APC project continues, the Western Australian Plant Census is updated to reflect the consensus view.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- A total of 256 new names were added to WACensus, with 90 being new manuscript or phrase names and 166 being published names.
- A total of 312 edits were made to WACensus.
- WACensus updates are regularly distributed to over 465 registered Max users on a monthly basis.
- Ca. 200 moss names added to WACensus.

*Management implications*

- All DEC systems utilising 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, moss and algae. Work during 2009-2010 will add liverworts and slime moulds.

## The Western Australian Herbarium's specimen database

Core Function

*Team Members*

S Carroll (0.6), M Falconer (0.4), E McGough (0.5).

*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.

*Aims*

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 (2008/09) and main findings*

- 21 347 records were added during 2008-09 including 2 104 Priority Flora and 456 Declared Rare Flora.
- 128 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 normalised data entry.

## FloraBase – the Western Australian flora

Core Function

*Team Members*

A Chapman (0.6), B Richardson (0.4).

*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.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- Ongoing implementation of a 5-year rolling plan to move FloraBase to become a complete Flora of Western Australia.
- Commenced development of a model for the technology and content to appear in FloraBase 3.
- Ongoing implementation of a staged roll-out of features and improvements as documented in the Herbarium's issues tracking tool (MANTIS).

- Completed improved management for 36 083 taxon images available in FloraBase.
- Completed weed management content for the weeds of the Swan Region, in collaboration DEC's Urban Nature Program staff.
- Added direct links from FloraBase to 13 213 taxon maps in the NatureMap web application.
- Progressed mechanisms for 'harvesting' authoritative descriptions from the Flora of Australia for use within FloraBase.
- Progressed the integration of available PDF's of *Nuytsia* journal protologues more tightly into FloraBase.
- Progressed the addition of full access to all Census data fields for query and display in FloraBase.
- Ongoing addition of upgraded map display (Extension to FloraBase Spatial Query).
- Ongoing maintenance of generic and family descriptions and other features.
- Presentation given and FloraBase poster displayed at international Taxonomic Database Working Group Conference, October 2008.
- Collaboration with DEC's Eco-Education unit, 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 13 213 currently recognised native and naturalised 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 maximise 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)*

- Development of the third major version of FloraBase.
- Upgrade the management of coded species descriptions in line with the DESCAT Review.
- Add new content, including interactive keys for identification of plant groups at species level.
- Add further standards support to allow FloraBase to participate in national and international bio-infrastructure projects.
- Maintain the quality of information and the adequacy of software and hardware systems.

## 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.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- Organised and hosted the international Biodiversity Information Standards (TDWG) Annual Conference in October 2008.
- Completed design and delivery of Image Collection Management software to provide sophisticated management and service options for the WA Herbarium's 60 000 plant images.
- Improved functionality for updating and accessing 706 158 voucher specimen records.
- Progressed implementation of a web service interface to support provision of DEC biodiversity data to Australia's Virtual Herbarium and the Global Biodiversity Information Facility.
- Progressed implementation of Digital Object Identifiers across DEC bibliographic databases.
- Implemented the Life Science Identifier standard for tagging individual specimens, names, images and other biodiversity data uniquely.
- Implemented the new Australia's Virtual Herbarium web service.

*Management implications*

- 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 biodiversity informatics tools will further aid efficiencies in flora management within the State.
- Collaboration with scientists, external agencies and standards organisations at national and international levels that aim to standardise biological data and build flexible management and visualisation software on top of these standards will maximise efforts to deliver qualitative improvements in the persistent documentation of global biodiversity.

*Future directions (next 12-18 months)*

- Implement use of Image Collection Management software and conduct training to Herbarium staff and volunteers.
- Launch of the Council of Heads of Australasian Herbaria's new Australia's Virtual Herbarium (AVH) web service.
- Collaborate with national (e.g. Atlas of Living Australia project, Herbarium Information Systems Committee) and international bodies (eg. TDWG, GBIF) 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.

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## 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# 2009/009

*Team members*

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

*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.

*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 (2008/09) and main findings*

- Paper accepted in the Records of the Western Australian Museum providing an annotated list of the marine plants of Mermaid Reef in the Rowley Shoals, Scott Reef and Seringapatam Reef.
- A paper describing the rediscovery of an extremely rare red alga was published. Two papers describing the latitudinal patterns of algal distributions have been accepted for publication in the Journal of the Royal Society of WA, as part of a special edition dedicated to the Leeuwin Current. A book describing Western Australia's common introduced species has also been published.

*Management implications*

- Enhanced knowledge of marine biodiversity allows a more accurate assessment of management and development proposals.
- Easier identification of marine plant species leads to a more comprehensive understanding of their conservation status, recognition of regions with high biodiversity and/or rare species, recognition of rare species, and recognition of potentially introduced species and discrimination of closely-related native species.

*Future directions (next 12-18 months)*

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

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

SPP# 2009/008

*Team members*

J Huisman (0.2), C Parker (0.2).

*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, 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.

*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 (2008/09) and main findings*

Several hundred species descriptions have been collated or newly generated. Some of these have been edited and uploaded to FloraBase, the remainder will be finalised late 2009.

*Management implications*

- Easier identification of marine plant species will lead to a more accurate understanding of their conservation status.
- Enhanced knowledge of marine biodiversity will allow a more accurate assessment of management proposals/ practices.
- Provision of 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.

*Future directions (next 12-18 months)*

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

## 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) .

*Context*

Knowledge of the fungi and other cryptic organisms that help keep 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 and the Perth Urban Bushland Council, in conjunction with the Western Australian Herbarium.

*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 (2008/09) and main findings*

- Conducted 107 workshops and forays in 51 urban bushlands.
- Produced foundation fungi inventories for 33 bushlands.
- Recorded 4267 fungi.
- Processed and vouchered about 1000 fungi specimens for WA Herbarium collection.
- Published fungi reports for seven community group bushlands, and made these available online.
- Published *Fungi of the Perth Region and Beyond* - and made this book available online at the PUBF website at www.fungiperth.org.au.

*Management implications*

- 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 plants healthy is essential for effective conservation management of this hotspot region.

*Future directions (next 12-18 months)*

- Conduct six public field events (forays and workshops) and a contracted survey during the 2009 season.
- Translate protocols developed by PUBF to regions beyond the coastal plain of Perth.
- Further the incorporation of PUBF fungal specimen data and species images into WA Herbarium databases.
- 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.

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## Improving the comprehensiveness, accuracy and availability of taxonomic data about WA's fungi in DEC biological datasets and biodiversity collections

SPP# to be 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, misidentified, 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 the 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 (2008/09) and main findings*

- Published journal papers concerning fungi genera *Inocybe*, *Laccocephalum*, *Mycena*, *Descomyces*, and various sequestrate fungi.
- Submitted a journal paper about fungi enabling successful translocation of Gilbert's Potoroos.
- Submitted a journal paper on the interaction between native beetles and fungi.
- Census data compiled for species represented in *Fungi of the Perth Region and Beyond*.

*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 regional 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.
- Continue updating 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 further fungi taxa in WA.

## Taxonomic studies in Epacridaceae, Rafflesiaceae, Rhamnaceae and Violaceae

SCP# 2007/015 (SPP# to be allocated)

*Team member*

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.

*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 (2008/09) and main findings*

- Two new and geographically restricted species of *Hibbertia* from the Ravensthorpe Range have been identified and described. *Hibbertia abyssa* Wege & Thiele is known from only a single population adjacent to the nickel mine on Bandalup Hill, and has been nominated for listing as Declared Rare Flora. *Hibbertia atrichosepala* Wege & Thiele is a narrow range endemic of rocky, lateritic habitats in the Ravensthorpe Range and is listed as having Priority One conservation status. A paper describing these two species has been submitted to *Nuytsia*.
- Three new species of *Hibbertia* have been described from the Lesueur Sandplain region north of Perth. All three species are geographically restricted but relatively well conserved in Nature Reserves and National Parks in the region. Two of the species were previously known under phrase names. A paper describing the species has been completed ready for submission to *Nuytsia*.
- A new species of *Banksia* (formerly included in *Dryandra meganotia*) from the Wandering district has been described. The new species, *B. recurvistylis* is geographically restricted and has been given a conservation rating of Priority 2. A paper describing the new species has been submitted to *Nuytsia*.
- Revision of the *Lysinema ciliatum* species complex (Epacridaceae) has been completed. 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 only two species are present. Examination of type material in European herbaria shows that both of these were collected and described by Robert Brown in 1802. These studies have shown that the true *L. ciliatum* is largely restricted to the south coast between Esperance and Albany. The more widespread species, occurring throughout the South West Botanical Province that has been known as *Lysinema ciliatum* for nearly 150 years, is *L. pentapetalum*. A paper has been prepared and is ready for submission to *Nuytsia*.

*Management implications*

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

*Future directions (next 12-18 months)*

- A new species of *Hybanthus* with a very restricted distribution in the Ravensthorpe Range has been discovered and will be described.
- Work on the taxonomy of undescribed species in *Hibbertia* (Dilleniaceae) will proceed and is

expected to lead to many new species.

## Development of interactive identification platforms and content

SCP# 2007/014 (SPP# to be allocated)

*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 (2008/09) and main findings*

Keys to all genera of Proteaceae in Western Australia have been substantially progressed and are being prepared for final publication.

*Management implications*

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

*Future directions (next 12-18 months)*

- Publish the key to Proteaceae on CD and Florabase.
- Continue development on a range of keys for other families.

## Surveys, systematics and genetic diversity of granitic vernal pools flora

SPP# to be allocated

*Team member*

M Moody (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 recognised 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 and likely to lead to the discovery of 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.

*Aims*

- 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 survey ecological factors that are important to these systems (e.g. water depth, sediment nutrient content, etc.).

*Summary of progress (2008/09) and main findings*

- Conducted observations and plant collections at granites of Cape Arid and Cape Le Grand National Parks and the central wheatbelt, north-east to Kalgoorlie.
- Sequence data has been collected from the rare species *M. lapidicola* showing particularly strong divergence from all other taxa in the genus and unexpected taxonomic relationships in the genus.
- Examination of taxa from the sandstones of the Kimberley and of the P2 *M. callitrichoides* has uncovered species level divergence likely leading to the description of a new species.
- DNA extractions from *Glossostigma* spp. and *Isoetes* spp. have been performed and preliminary sequence data has been collected.
- Identified transferability of microsatellite markers to *Myriophyllum balladoniense* (Priority 4) from those developed for *Myriophyllum spicatum*. These markers may be useful for population level studies among rare or priority species of this genus in WA vernal pools.

*Management implications*

Identification of unique lineages and rare species will lead to better, more targeted conservation plans. The vernal pools are under particular threat due to global climate change, especially those reaching through the wheatbelt, several of which were found dry in spring 2008.

*Future directions (next 12-18 months)*

- Test microsatellite markers developed for other *Myriophyllum* spp. for transferability to those rare and priority in the vernal pools, particularly the DRF *M. lapidicola*.
- Continue to collect molecular data on species of *Glossostigma*, *Isoetes* and *Myriophyllum*.

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# LANDSCAPE CONSERVATION

**Program Leader: Dr Lachlan McCaw**

Applied research undertaken by the Landscape Conservation Program seeks to understand the factors and processes that determine the overall health and productivity of lands managed by the Western Australian Department of Environment and Conservation (DEC), which include State forests, national parks and other conservation reserves. This research is aligned to the information needs of DEC and the Forests Products Commission. Strong collaborative linkages exist with universities, cooperative research centres, CSIRO and other research institutions and the corporate sector.

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

SPP# 2006/003

*Team members*

R Robinson (0.25), L McCaw (0.2), J Farr (0.25), K Whitford (0.3), R Cranfield (0.2), A Mellican (0.1), G Liddelow (0.2), J Fielder (0.2), V Tunsell (0.8), B Ward (0.2), A Wills (0.2), P Van Heurck (0.1).

*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.

*Aims*

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 (2008/09) and main findings*

- Nine grids in the Wellington district were re-measured during 2008/2009, with data collected for cryptogams (lichens, liverworts and mosses), macrofungi, vascular plants, invertebrates, terrestrial vertebrates, birds, litter and stand structure (basal area and stocking of overstorey species). Supplementary data were gathered on size and condition of coarse woody debris at each site.
- The 2008-09 annual report for the Donnelly grids was completed and is available on the DEC website at: http://www.dec.wa.gov.au/science-and-research/landscape-research/forestcheck-index-page.html. Findings were presented to Donnelly District and Warren Region staff in March 2009.
- Six draft papers have been prepared, and a further three are near completion, dealing with results of analysis for the first five years of monitoring.

*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 will be finalised.
- Draft papers to be submitted for publication in the last quarter of 2009.

## Monitoring 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).

*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 to protect life and property. This study, established in 1972 in Lindsay forest west of Manjimup, and in 1986 in Perup forest east of Manjimup and McCokhill forest west of Nannup, was designed as a long-term experiment.

*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 (2008/09) and main findings*

- A paper comparing tree diameter growth rates and crown condition over 20 years at the Perup forest site and under different fire treatments has been submitted for publication. Slowest growing trees were associated with long unburnt plots, even though these plots generally had higher soil nutrient levels than frequently burnt plots. Competition for water probably explains the slower growth rates. There was no clear pattern of tree growth and tree health amongst the various fire treatments and there was no evidence that either long periods of fire exclusion or frequent burning had chronic effects on tree health. Tree dominance condition explained most variation in tree diameter growth.
- Spring and autumn burn treatments were applied at the Perup and McCorkhill sites.
- A complete assessment of understory vegetation of all sites was undertaken with a view to analysing and publishing findings to date. There are indications that grazing by native macropods is having a significant impact on vegetation in the small burnt study sites.

*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 per annum) jarrah forest. Water stress will lead to reduced growth rates so stand density and leaf area index may need to be managed to maintain healthy forests in a drying climate.

*Future directions (next 12-18 months)*

- Maintain fire treatments at both study sites.
- Publish tree growth findings.
- Analyse all data on the effects of various fire regimes on understorey vegetation after 20 years of monitoring and prepare a paper for publication.

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

(see also Rangelands Restoration – reintroduction of native animals to Lorna Glen page 90)

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 (0.2), Prof T Bragg (University of Nebraska, Omaha).

*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.

*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 (2008/09) and main findings*

- A successful feral cat, fox and wild dog baiting operation was carried out again in 2008 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 few animals recorded.
- Fauna reintroductions: See “Rangelands Restoration – reintroduction of native animals to Lorna Glen (p. 90).
- Fire ecology (plants) and biodiversity monitoring sites were re-assessed. There are indications that predator control is increasing the diversity and abundance of extant ground dwelling vertebrate fauna, but this needs further analysis and may become more apparent with time.
- Strategic buffer and research burning was successfully carried out according to the fire management plan.
- Installation of new boundary fencing is near completion.
- Fire management plan was revised.

*Management implications*

- Information will inform 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 will reduce this threat to native fauna.

- Reintroduction and protection of arid zone rangelands mammals, other extant fauna, vegetation and other elements of the biota will provide reconstruction of animal and plant assemblages in an arid zone ecosystem.
- 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 sixth annual feral cat and fox baiting program in July 2009.
- Construct an acclimatisation compound for future fauna reintroductions.
- Consider increasing the population of bilbies and brushtail possums by further reintroductions.
- Reintroduce another two native mammal species.
- Continue to monitor extant fauna and vegetation (biodiversity monitoring sites).
- Complete analysis and write-up of first stage of fire ecology study.
- Implement revised fire management plan.
- 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 publicise all facets of the Rangelands Restoration project.
- Seek partnerships with corporate sector.

## Burning for biodiversity: 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), V Tunsell (0.1), P Van Heurck (0.1), A Wills (0.1). 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 Western Australia. There is a substantial body of scientific evidence that, within ecologically circumscribed parameters, fire diversity can benefit biodiversity at the landscape scale. We hypothesise 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 homogenising wildfires.

*Aims*

- To determine whether a fine-scale mosaic of vegetation at different seral (post-fire) stages benefits biodiversity at the landscape scale. Specifically the project will investigate:
    - 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*, *Banksia formosa*, *Hakea oliefolia*) under this fire regime.
    - 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 (2008/09) and main findings*

According to plan, patch-burning was carried out by helicopter ignition in December 2008. Additional monitoring sites were established. Satellite imagery of 2008 burning has been prepared. Early indications are that fire mosaics are providing greater diversity of seral stages, particularly for invertebrate fauna.

*Management implications*

The study demonstrates that fine grain patch-burning is operationally feasible in forest areas. The benefits to biodiversity are yet to be fully assessed – this will take time to emerge.

*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 2010.
- Establish and assess further grids in long unburnt vegetation as the mosaic shifts.
- Patch-burning is scheduled for spring 2010 or 2011 depending on outcome of analysis of satellite imagery.
- Finalise production of a video explaining the purpose and findings of the study.

## 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), M. Millar (0.1).

*Context*

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

*Aims*

To provide genetic information for the conservation and utilisation 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 (2008/09) and main findings*

- *A. saligna* – Reproductive biology paper has been published in Journal of the Royal Society of Western Australia. Genetic diversity in additional populations of the complex has assisted the taxonomic identification of these unresolved populations and clarified the geographic distribution of the subspecies.
- *S. album* – Genetic diversity paper has been accepted for publication in Silvae Genetica.
- *E. occidentalis* – Correlation of genetic relationships between parental trees and fitness of progeny

from a crossing experiment involving close and distance crosses showed that progeny from more genetically distant crosses had greater survival and growth. Paper has been submitted for publication in Silvae Genetica.

*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 hybridisation in natural populations.
- *E. occidentalis* – Improved survival of progeny from wide crosses under saline conditions and low genetic structure among families implies breeding with salt and/ waterlogging tolerant individuals would result in substantial increases in salt and/ waterlogging tolerance, but no decline in genetic diversity.

*Future directions (next 12-18 months)*

- Journal paper detailing genetic diversity in additional populations of *A. saligna* will be written.
- Journal paper describing genetic diversity in *A. microbotrya* will be written.

## 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).

*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.

*Aims*

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 (2008/09) and main findings*

- *Bossiaea ornata* – Genotyping of 20 individuals from 20 populations has been completed and data are currently being analysed.
- Paper has been published in Journal of the Royal Society of Western Australia.
- Report providing guidelines for seed collections for revegetation in the forest prepared for SFM.
- Information sheet published.

*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 *Kennedia coccinea* will be collected, DNA extracted and genetic analysis commenced.

## Management of environmental risk in perennial land use systems

SPP# 2004/003

*Team members*

M Byrne (0.2), L Stone (1.0), J Sampson (1.0).

*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, hybridisation with native species and gene flow from cultivated populations into natural populations.

*Aims*

- To develop and implement procedures for management of environmental risk in the form of assessment and management protocols to be applied to all germplasm under development within the Future Farm Industries (FFI) CRC.
- To determine the mechanisms, extent, implications and management of genetic risk for selected taxa in commercial development.

*Summary of progress (2008/09) and main findings*

- WRAs completed for ten exotic and seven native forage and woody species; published on line at FFI CRC website.
- Environmental risk management policy revised for application in the FFI CRC with genetic risk included.
- Draft genetic risk assessment developed.
- Journal paper on an environmental weed risk management strategy for pasture research programs published in Plant Protection Quarterly.
- Continued involvement in national discussions on improvements to border and post-border weed risk assessment.
- National weed risk management forum established and commenced construction of on-line weed database.
- Data analysis undertaken 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.
- Continued monitoring of the impact of the exotic species *Plantago lanceolata* on regeneration of native flora following a fire.
- Analysis of genetic structure in *Atriplex nummularia* and genetic differentiation between subspecies completed.
- Conference paper entitled 'Which WRA works for WA? A comparison of weed risk assessment models' presented at the 16$^{th}$ Australian Weeds Conference, Cairns, 2008.
- The genetic identity of weedy populations of *Acacia saligna* has been determined using genetic markers and all populations evaluated were subspecies *saligna* and were spreading by seed rather than by suckering.
- Format for species management guide for land holders developed, and a sample guide drafted using Kikuyu as a sample species, FFI CRC partners and stakeholders engaged for wider comment.

*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 hybridisation to be assessed and lead to development of risk management guidelines.

*Future directions (next 12-18 months)*

- Continue development of genetic risk assessment and invite comment from scientists within and external to FFI CRC.
- Consult with breeders and production scientists on development of individual management guides for key species with some weed potential but significant agricultural benefit for publication by the FFI CRC.
- Develop field trial guidelines for researchers for evaluation of forage and agro-forestry species in FFI CRC in consultation with agencies and stakeholders across Australia.
- Continue technical advice to FFI CRC researchers on weed issues, including new WRAs.
- 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.
- Participate in the national weed risk management forum and contribute to the on-line database.
- Write paper on genetic identification of weedy populations of *Acacia saligna*.
- Prepare paper for publication of field trial guidelines.

## State Salinity Strategy wetland monitoring

SPP# 1998/018

*Team members*

Fauna - A Pinder (0.1), D Cale (0.4); Flora - M Lyons (0.2), C. McCormick (0.75); Surface water - J Lane (0.7), A Clarke (0.5), Y Winchcombe (0.4), B Muir (0.05); Groundwater - M Lyons (0.05).

*Context*

Substantial loss of biodiversity has occurred across the Wheatbelt of Western Australia over the past 100 years. The most pronounced physical changes to wetlands have been associated with native vegetation clearing and salinisation. Broadscale clearing has more or less ceased but salinisation and fragmentation processes will continue to be expressed for many decades. While it is known that salinisation is a major threat to wetland biodiversity, the relationships between its physical expression and loss of biodiversity are poorly documented and poorly understood. This project began in 1997 and is designed as a long term monitoring project.

*Aims*

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 (2008/09) and main findings*

- Fauna monitoring – field component of 2008 monitoring completed, invertebrate dataset being incorporated into comprehensive reports on data collected between 1997 and 2006. A fauna and water chemistry monitoring project was designed for the Lake Warden system.
- Surface water monitoring – 2008 depth and water quality monitoring was undertaken, and data added to the SWWMP database and supplied to managers. High resolution oblique aerial photography was taken for an additional 46 SWWMP wetlands. Scope, outputs and linkages were reviewed at sub-program level. The annual SWWMP report was produced presenting all routinely-collected 1977-2007 depth, salinity, pH and nutrient data.
- Wetland bathymetry – Bathymetric mapping was undertaken for Byenup Lagoon.
- Vegetation monitoring for 2008 completed. Database of 1997-2007 vegetation data completed and edited. Data being incorporated into reports on trends in vegetation condition for all wetlands during 2009/2010 financial year.
- Ground water monitoring - for 2007/2008 completed and data compiled. Routine logger and bore

maintenance completed for 2007/2008. Trends in shallow groundwater from 1997-2008 to be included in wetland reports for 2009/2010.

- Reporting – Draft ten year review of all project components produced for review of wider State Salinity Strategy. Progress made on collating all fauna, vegetation and water chemistry data from 1996-2006 into reports on 25 intensively monitored wetlands.

*Management implications*

- Monitoring of depths, salinities and pH of 101 SWWMP wetlands reveals a number of wetlands undergoing changes that warrant further investigation and corrective management.
- Loss of vegetation is continuing even at long-salinised 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 (eg. Coomalbidgup Swamp) as groundwater management in maintaining wetland health and greater focus on surface water is required.

*Future directions (next 12-18 months)*

- Continue monitoring according to current protocols.
- Produce 1977-2008 and 1977-2009 annual SWWMP reports during 2008/2009 financial year.
- Continue to produce reports on all data collected between 1997 and 2006 during 2009/2010 financial year.
- Present results of fauna monitoring program at a national aquatic science conference.
- Obtain high resolution, oblique aerial photography of additional monitored wetlands.
- Undertake bathymetric surveys of additional monitored wetlands.

## Monitoring stream biodiversity (KPI 20 of the Forest Management Plan)

SPP# 2006/002

*Team members*

A Pinder (0.15), K Sutcliffe (0.25), M Pennifold (0.70).

*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.

*Aims*

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 (2008/09) and main findings*

- The fourth round of sampling was completed in 2008.
- Macroinvertebrate identification and water chemistry analysis have been almost completed for these samples.

*Management implications*

Management implications will be identified following analysis of data collected 2005-2008.

*Future directions (next 12-18 months)*

- Data from the third and fourth round of sampling to be analysed and evaluated using the AusRivAS model.

- Fifth round of sampling to be undertaken in spring 2009.

## Investigating relationships between aquatic invertebrates and habitat characteristics as a contribution to determining ecological water requirements in Pilbara river pools

SCP# 2009/004

*Team members*

A Pinder (0.1), A Leung (0.9).

*Context*

The Department of Water (DoW) is investigating options for new groundwater resource developments in coastal parts of the Pilbara. As part of the assessment process for selecting and developing these resources DoW requires information on the conservation significance and ecological water requirements of the biota inhabiting groundwater dependent river pools.

*Aims*

To assess the conservation significance and habitat requirements of aquatic invertebrates inhabiting selected river pools in each of three priority areas.

*Summary of progress (2008/09) and main findings*

- The report is nearing completion.
- Main findings are that invertebrate communities in the lowland pools of interest are not significantly different to those of more inland parts of the Pilbara.
- There are differences in composition between catchments but these can be attributed to physical and chemical differences between pools. Invertebrate composition is not strongly related to pool size but is related to a range of other pool characteristics.

*Management implications*

Implications will be identified once the report is completed.

*Future directions (next 12-18 months)*

Project ends July 2009.

## Establishing a baseline wetland condition monitoring program for WA

SPP# 2008/001

*Team members*

A Pinder (0.1), N Guthrie (0.6), R Gordon (1.0).

*Context*

There is little information on the condition of wetlands across large areas of the State against which to prioritise and assess management actions. This project is part of a broader project, funded by the National Action Plan for Salinity and NHT2, to assess the current condition of inland aquatic natural resources, assess effectiveness of on-ground investments and set and report on achievement of regional resource condition targets.

*Aims*

To contribute invertebrate diversity and water chemistry data to baseline condition reports for 45 of the State's most significant wetlands.

*Summary of progress (2008/09) and main findings*

- 45 wetlands were selected and sampled for indicators of condition, including biodiversity and

physico-chemical measures.

- All wetlands were sampled in spring 2008.
- Data on invertebrate diversity and water chemistry has been collected and is being incorporated into reports that also summarises previous data, describes the wetlands, their driving processes and threats.

*Management implications*

The current condition of these wetlands has been documented and this will serve as a baseline for future monitoring and assessment of management actions.

*Future directions (next 12-18 months)*

- Project ends September 2009.
- The project will produce a resource that can be incorporated into conservation management activities of regional groups.

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## Bushfire CRC Project 1.4: Improved methods for the assessment and prediction of grassland curing

SPP# 2007/007

*Team members*

L McCaw (0.05).

*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.

*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;
    - establishing five regional sampling sites representative of the major grasslands of Western Australia, and
    - collecting and analysing grassland curing data from these various grasslands.

*Summary of progress (2008/09) and main findings*

- Curing was sampled for a third spring (October to December) at Simcocks property near Manjimup and data will be used to evaluate consistency of curing estimates between seasons.
- A new curing algorithm has been developed using field data from a wide range of grasslands in Australia and New Zealand. This algorithm is superior to the one currently in use which was derived for annual grasslands in Victoria.

*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 modelling, will allow improved predictions of fire behaviour.

*Future directions (next 12-18 months)*

The new curing algorithm will be validated in southern and northern Australian grasslands during 2009 and findings of the project prepared for publication.

## 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. Ministerial 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 quality.

*Aims*

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 (2008/09) and main findings*

- Monitoring of groundwater levels, stream flow, stream salinity and stream turbidity in the two treatment catchments and in the control catchment continued during 2008/09.
- Eight years after treatments peak groundwater response, relative to the control catchment, was about 1.7 m in the intensive-treatment catchment and about 1.3 m in the standard-treatment catchment. There was no measurable streamflow or stream salinity response to the treatments, relative to the control, because the saline groundwater table was disconnected from surface water and continued to decline following the treatments and hence did not contribute to streamflow.
- Data for the eight year period following harvesting have been summarised in a detailed progress report. Key findings identified in this report are that a drying climate has masked the effects of timber harvesting and silvicultural treatments on 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.
- Findings of the study were presented to a workshop on water resource management in September 2008.

*Management implications*

- The strong relationship between the magnitude of vegetation reduction and the extent of groundwater rise can guide harvesting and silvicultural practices.
- The risk of increased stream salinity from current harvest and silvicultural practices is lower than with past practices because the prevailing drying climate and retention of more vegetation following harvest results in a more subdued groundwater rise than in the past.
- 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 papers in scientific journals on the observed regional decline in groundwater level and the responses to timber harvesting.
- Prepare an information sheet summarising the key findings of the study.

## Directory of important wetlands in Australia: revised editions

SPP# 1999/014

*Team members*

J Lane (0.05), S Elscot (0.05)

*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 prioritising wetland conservation activities in Western Australia and nationally.

*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 (2008/09) and main findings*

This project, completed in April 2009, has achieved:

- Nomination of 10 new nationally important wetland sites in under-represented IBRA Regions of Western Australia.
- Improved documentation for 25 of the 27 existing wetland sites within the 15 under-represented IBRA Regions.
- Gathering of a substantial amount of new information, including field data, from 119 wetlands within the under-represented IBRA Regions which will assist in identifying potential wetlands for future listing.
- Field data collected for the project has also contributed to a database of the distribution of aquatic invertebrates in WA and will improve knowledge of the biogeography of these taxa in WA.

*Management implications*

Literature search, field survey results and interviews have led to identification of nationally important wetlands, values and threats and provided a basis for conservation and wise management of these wetlands.

*Future directions (next 12-18 months)*

Project completed.

## Management of the Vasse-Wonnerup wetlands

SPP# 1999/017

*Team members*

J Lane (0.20), A. Clarke (0.3), Y Winchcombe (0.1).

*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.

*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 (2008/09) and main findings*

- A meeting of the inter-agency Vasse Estuary Technical Working Group was convened to decide arrangements for 2008/2009 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 during 2008/09. 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 provided 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, and to GeoCatch concerning water level management of Vasse-Wonnerup.
- In collaboration with DEC Bunbury, SWCC and GeoCatch, and the involvement of Landgate and the DEC GIS Section in Kensington, the bathymetry of Vasse-Wonnerup and the adjoining floodplain was surveyed and mapped to a high level of precision. This will enable the extent and magnitude of potential impacts of changes to water levels of the system to be predicted with far greater accuracy than previously.

*Management implications*

Water levels, flows and fish movements were successfully managed throughout summer-autumn of 2008/09. 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)*

- Preparation of bathymetric maps of Vasse-Wonnerup and the adjoining floodplain.
- Initiate a study of historical (pre and post 1830s) use and management of Vasse-Wonnerup and its floodplain, subject to availability of external funding.
- The Vasse Estuary Technical Working Group will be convened as necessary to decide on management, monitoring and other responsibilities.
- Monitor water levels and fish activity during summer-autumn to guide the use of gates for managing water levels and fish populations.
- Respond to public enquiries concerning management of the wetlands.
- Prepare a concise report documenting 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.

## 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.

*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.

*Aims*

To monitor impact of severe wildfire in karri/tingle forest on plants, invertebrates, vertebrate fauna and stand structure.

*Summary of progress (2008/09) and main findings*

There was no activity on this project during 2008/09.

*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 will be analysed for consolidation in a progress report, and selected datasets will be prepared for scientific publication. This will include examination of changes in bird assemblages, numbers and density at each of 12 survey points. Further measurements may be made in 2011 to provide data for ten year post-fire responses.

## Long-term monitoring of impact of timber harvesting on bird populations in south-west forests

SPP# 1994/008

*Team Members*

I Abbott (0.01), A Mellican (0.01), G Liddelow (0.01), C Vellios (0.01), V Tunsell (0.01), M Williams (0.01).

*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.

*Aims*

To quantify the effects of timber harvesting and silvicultural practices in the karri and jarrah forests on birds.

*Summary of progress (2008/09) and main findings*

A paper presenting results from long term monitoring of bird populations after logging in forests in south-west Western Australia has been accepted 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.
- 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.

*Future directions (next 12-18 months)*

- Counts are scheduled for the Kingston plots in 2011 (15 years after regeneration).
- Counts at the Gray plots should be repeated less frequently (every 15 years), with the next due in 2021 (36 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 so that scheduled bird counts are not compromised by the introduction of confounding factors.

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

SPP# 1997/003

*Team members*

L McCaw (0.3).

*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 recognised limitations in previous fire behaviour prediction models for dry eucalypt forests.

*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 characterise wind speed profiles in forests with different overstorey and understorey structures.

*Summary of progress (2008/09) and main findings*

- A knowledge transfer program including field-based training in the use of the fuel hazard rating system and the fire behaviour prediction system was implemented during 2008 with more than 500 fire practitioners participating in workshops in six states and the ACT.
- A manuscript describing the fuel moisture prediction module of the fire spread model has been accepted for publication in the International Journal of Wildland Fire.

*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)*

Complete publication of scientific papers on fuel description, fire behaviour experiments, flame dimensions and spotting.

## Increasing productivity of karri regrowth stands by thinning and fertilising

SPP# 1993/106

*Team members*

L McCaw (0.05).

*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.

*Aims*

- 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.
    - Fertilising with macronutrients and trace elements.
    - Coppice control.

*Summary of progress (2008/09) and main findings*

There was no activity on this project during 2008/09.

*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)*

- Re-measurement of the Warren experiment is scheduled for 2009/10 and may incorporate a further thinning treatment in some plots.
- Review silvicultural experiments in conjunction with Forest Management Branch to determine priorities for re-measurement in the period 2009-2011, taking into consideration requirements of the Forest Management Plan and emerging issues including climate change.

## Espacement effects on the development and form of regrowth karri stands

SPP# 1993/107

*Team members*

L McCaw (0.05).

*Context*

Karri forest is regenerated following clearfell timber harvesting by planting with nursery-raised seedlings. Initial planting density has important long term effects on the productivity and growth form of regenerated stands. Planting densities were increased during the 1990s in recognition of the fact that some stands planted at 1250 stems per ha had poor form with persistent large branches and short boles. This trial was established in 1991 and is periodically re-measured to assess tree and stand

growth, survival and tree form. The trial was last measured in 2000.

Aims

To quantify the effects of initial stocking and espacement on stand growth, tree growth and form of karri planted following clearfell harvesting operations. This trial employs a scotch plaid design with four replicate blocks each providing examples of nine spacings ranging from 800 to 5000 trees per ha.

*Summary of progress (2008/09) and main findings*

- Tree diameter and survival were re-measured between February and June 2009.
- Since the previous measurement in 2000 the relative dominance of individual trees has become clearly established and many of the suppressed trees have died through competition. Initial planting densities above 3000 stems per ha do not appear to confer any significant improvement in the form of dominant or codominant trees.

*Management implications*

Current guidelines for planting density in regenerated karri stands appear soundly based.

*Future directions (next 12-18 months)*

- Complete measurement of tree height and branching habit.
- Prepare a manuscript comparing survival, growth and form of planted karri for the period 1991-2009.

## 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.

*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 (2008/09) and main findings*

- A manuscript describing the potential of *Callitris preissii* for dendrochronology has been accepted for publication in Dendrochronologia. This paper confirms that tree rings can be used to accurately date the year of past fire events. Tree rings of Callitris showed strong inter-series correlation across a broad area suggesting consistent growth response to regional environmental factors.

- Manuscripts describing climatic and vegetation influences on fire patterns are being prepared for submission to scientific journals in 2009.

*Management implications*

Fire managers will be better informed about current fire regimes and the need for active intervention through planned burning or fire suppression, and potential effects of changing patterns of rainfall and temperature in southern Western Australia.

*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 with sampling in the Kimberley during 2009.

## Fire regimes and biodiversity decline in the Kimberley

SPP# 2007/008

*Team members*

I Radford (1.0), R Fairman (1.0).

*Context*

Recent studies in the Northern Territory have shown declines in critical weight range (CWR) mammals (35g-5kg) and some species of birds and shrubs. Biodiversity declines in otherwise intact landscapes have been attributed to increased intensity and frequency of fires. Studies in central Australian arid environments have also highlighted the strong influence of fire, combined with introduced predators, on mammal species abundance. 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. A direct link between abundance of threatened animals and fire regimes in this region has yet to be established. This study will establish whether fire has 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 CWR mammals by analysing vegetation structure and resource dynamics.

*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-colonisation 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 (2008/09) and main findings*

- Eighteen sites on sandstone and laterite substrates were measured in 2007, with eight sandstone sites chosen for longer term studies continuing through 2008 and 2009. Results show that mammals and other groups respond to time since the most recent fire. Some species including northern quolls, several small skink species and large ground dwelling invertebrates preferred open areas burnt within the previous year. Rodents, bandicoots and larger skinks such as *Ctenotus inornatus* were more numerous in older vegetation (>two years since fire).
- No single fuel age will benefit all species, but the rarity of older fuels means that burn prescriptions should aim to provide patchiness and retain medium sized patches (>10 ha) of vegetation >two years since fire.
- Fire mosaics that include both recently and long unburnt patches appear to protect mammals from localised losses. In mosaic burnt areas mammals did not disappear after fires, presumably because they were able to recolonise rapidly from adjoining unburnt patches. In contrast, some mammals including quolls and common rock rats were not found up to 2 years post-fire following uniform broadacre fires. This is interpreted as a reflection of the time required to re-colonise from isolated

fire refuges.

- The Mitchell River region is not uniformly good habitat for mammals. Sandstone areas had good populations of mammals but laterite woodlands did not. Mammal numbers appear to be related more to habitat structure (grass biomass, shrub cover) than food resources, though this needs further testing. Mammal conservation status in the north Kimberley is not assured, and current fire regimes in many woodland habitats are probably not optimal for mammals.
- Fire scar mapping for the period 2000 to 2007 was completed by Dr Li Shu of Fire Management Services Branch. Fire scars were verified by DEC staff familiar with the local area. Fire-scar mapping identified two distinct regimes of contrasting burning mosaics. The first, typical of most of the north Kimberley, was dominated by large-scale dry season fires (>5 $km^2$) with few unburnt fragments. The second was mosaics (e.g. surrounding Mitchell Rangers camp and Mitchell Falls walking track) made up of small-scale fires (1–100 ha) ignited for management purposes or by lightning (November-April).
- A progress report outlines findings and management implications from this study. A literature review resulting from this study and on the effects of fire on biota in northern Australia has been submitted to Conservation Science for publication.

*Management implications*

Persistence of CWR mammals will be favoured by fire regimes that retain patches of vegetation unburnt for more than two years as a significant part of the landscape (ca. 10-30% land area). Older vegetation patches should be at least 10 ha in size and distributed throughout the landscape. This will require fire managers to design ignition patterns specific to this objective.

*Future directions (next 12-18 months)*

- Finalise dry season monitoring of micro-chipped mammals, small vertebrates and invertebrates at Mitchell River sites during June/July 2009.
- Prepare manuscript on Influence of fire regime on mammal communities, time to recolonisation of burnt sites and putative mechanisms underlying fire effects (I Radford).
- Prepare manuscript on Influence of fire mosaic on northern quoll home range and population dynamics (A Cook UWA, & I Radford);
- Prepare manuscript on Ant species environmental/fire relationships and biogeography in the Mitchell (A Andersen CSIRO & I Radford)

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## *Armillaria* spread in karri

SPP# 1998/006

*Team members*

R Robinson (0.2), J Fielder (0.4).

*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.

*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 (2008/09) and main findings*

- Data from Warren thinning experiment checked and validated.

- Field tour of Warren thinning experiment conducted for ANU Forestry Students.

*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)*

- Review plan for second thinning of plots in the Warren thinning experiment.
- Review and incorporate this project into a forest health and vitality monitoring project.

## The effect of wildfire on forest fungi

SPP# 1998/015

*Team members*

R Robinson (0.1), J Fielder (0.1).

*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.

*Aims*

- To investigate the effects of wildfire on fungi in karri forest.
- To monitor the succession of fungi on burnt sites in karri forest.
- To collect vouchers and catalogue macrofungi in karri forest.

*Summary of progress (2008/09) and main findings*

- 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 published Robinson *et al* 2008. Epigeous macrofungal succession in the first five years following a wildfire in karri (*Eucalyptus diversicolor*) regrowth forests.
- Four articles published in newsletters (Western Wildlife, DEC News, Fungimap) based on results of this study.

*Management implications*

Results contribute to information on the management of fire for the conservation of biodiversity in eucalypt forest.

*Future directions (next 12-18 months)*

- Analysis of 10-year post-fire survey data continued.
- Laboratory work continues to catalogue and identify voucher specimens collected throughout the project.
- Collaborate with colleagues from other agencies with identification of voucher specimens.
- Analyse biodiversity data against rainfall and Soil Dryness Index measurements as a measure of fungal diversity in karri forest.

## Forest health and vitality surveillance and monitoring

SPP# to be allocated

*Team members*

R Robinson (0.15), J Farr (0.15).

*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.

*Aims*

To devise, establish and implement a Forest Health Surveillance (FHS) system for Western Australian forests.

*Summary of progress (2008/09) and main findings*

- Review paper published - Forest health surveillance in Western Australia: A summary of major activities from 1997-2006.
- A pest, disease and quarantine status report for WA forests was prepared and incorporated into the 2008-09 Research Working Group 7 (Forest Health) report for Australia and New Zealand.

*Management implications*

Pest and disease incursions can have major implications for economic and biological values of native forests and plantations and monitoring has a key role to play in timely and effective response to incursions.

*Future directions (next 12-18 months)*

- SFM to present concept to Regional Services for input and support of the (FHS) program.
- Develop an implementation plan for FHS.
- Prepare 2008-09 pest, disease and quarantine status report for WA forests.

## 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 minimise 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.

*Aims*

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 (2008/09) and main findings*

- Five permanent trial sites have been selected with different thinning regimes, dieback status and topographic positions.
- Four fully replicated trials with all trees marked have been established so far.
- Initial measurement of the trials is underway.

*Management implications*

- The project will provide scientific data and conclusions relating to key assumptions that underpin 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. 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 five trials, and analyse data.
- Continue site selection and establishment of trials at different sites, and carry out initial assessments and measurements on the new trials.
- Commence second year measurements on the first five trials.

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## 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); District staff - E Middleton; Walpole-Nornalup Parks Association and Walpole community volunteers.

*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.

*Aims*

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 (2008/09) and main findings*

- During 2008/09 the Nuyts beetle collection has been compared to beetle assemblages collected in the Bushfire CRC and Walpole fine grain mosaic burning projects. Results to date indicate that the

beetle fauna of the southern forests has a high level of local endemism. Beetle assemblages across these three studies, less than 30km apart, only share a small proportion of species in common.

- Protocols developed in this project for identifying, curating, databasing and placing large specimens reference collections on the website have also been applied to related projects. This includes use of high resolution imagery software and equipment.

*Management implications*

- The Nuyts Invertebrate Collection contains a large proportion of invertebrate species previously undescribed from 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.
- Training volunteers from the Walpole-Nornalup National Parks Association and Walpole community in biosurvey techniques has made possible the sorting of large numbers of specimens collected over the period of the study. Volunteers have gained a greater understanding of the use of prescribed fire in the conservation of biodiversity and are becoming increasingly interested and skilled in invertebrate biosurvey. Making high resolution images available on a website for the use of international taxonomists has facilitated rapid identification of reference collection morphospecies. This project has achieved a successful partnership between fire managers, scientists and the local community.

*Future directions (next 12-18 months)*

Publish aspects of this project as a comparative study of para-taxonomy training by local volunteers.

## Effects of timber harvesting on terrestrial vertebrates in medium rainfall jarrah forest

SPP# 1993/115

*Team members*

A Wayne (0.1), C Ward (0.2), C Vellios (0.2), M Maxwell (0.2).

*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 by trapping at least quarterly in 1994-2000 and 2004/2005 and ongoing spotlight monitoring on three transects at least six times per year.

*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 (2008/09) and main findings*

- Spotlight monitoring on the three standardised transects was maintained at six repeat surveys per transect per year.
- Quarterly trapping on the 22 grids is currently underway for the 2009 calendar year.
- Data collation and validation for trapping and spotlighting is complete and up-to-date.

*Management implications*

- Improved ecologically sustainable forest management practices will reduce impacts on fauna.
- Knowledge of the factors affecting the detection of possums by spotlighting will improve efficiency of methods used for fauna monitoring (e.g. Western Shield) and research.

*Future directions (next 12-18 months)*

- Analyse and publish the findings of immediate and short-term responses of medium-sized mammals to jarrah forest timber harvesting, based on trapping data.
- Analyse and publish the findings of the abundance of possums over time based on spotlight monitoring data.

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## 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 members*

K Whitford (0.3), Technical Officer (0.2).

*Context*

Hollow bearing trees and logs are elements of forest structure that are essential for the conservation of hollow dependant birds and mammals. Developing detailed knowledge of hollows and the attributes of trees and logs that bear these hollows improves DEC's capacity for ecological sustainable forest management. The study of standing trees is largely complete and the current work focuses on hollows in logs on the ground.

*Aims*

- To describe the size of tree and log hollows used by jarrah forest fauna species and the distributions of the sizes, shapes and orientations of these hollows.
- To determine the relationship between tree size and tree age for jarrah and marri and the minimum age and size of trees bearing hollows potentially suited to hollow dependant fauna species.
- To identify the types of trees and tree crowns that bear hollows and develop predictive relationships for hollow occurrence and abundance.
- 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 the numbers and types of logs and hollows present on the forest floor and site type, forest management and burning history
- Study the recruitment and decay of logs on the forest floor.
- To assemble information on the hollow log requirements of the various hollow dependent fauna in the jarrah forest.

*Summary of progress (2008/09) and main findings*

- The volume and condition of CWD has been re-assessed at 48 FORESTCHECK plots during the past 12 months and data are being used to examine the available volumes, structure and decay of CWD.
- A Landscope article describing the role and importance of CWD in forest ecosystems was published.

*Management implications*

This research contributed to knowledge of hollows and hollow use in the jarrah forest and the results were the basis for much of Appendix 5 of the silviculture guidelines, Silvicultural Practice in the Jarrah Forest.

*Future directions (next 12-18 months)*

Further analysis of CWD data from FORESTCHECK plots to identify the gaps in knowledge required to fulfill the aims of this study.

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

SPP# 1999/021

*Team member*

K Whitford (0.2).

*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.

*Aims*

- To investigate the use of soil organic matter as an indicator of ecologically sustainable forest management and examine the impact of fire on organic C and N in the jarrah and karri forest.
- To provide a scientific basis for the soil disturbance monitoring and management system applied in the jarrah and karri forests by establishing base data on the intensity and extent of soil disturbance in harvesting coupes, and developing, refining and implementing survey techniques for estimating soil disturbance
- 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 investigate the impact of extraction track compaction on tree and stand growth in the karri forest.

*Summary of progress (2008/09) and main findings*

- Findings from adaptive trials designed to test the effectiveness of cording techniques to protect soils from damage during harvesting operations have been analysed.
- Soil compaction was found to increase rapidly following the first few passes by harvesting machinery, with the rate of increase reducing as successive trafficking occurred.
- Visual assessment of soil compaction is an effective way of quantifying the extent of damage for operational management purposes.
- Soil compaction is ameliorated slowly by natural soil processes over time, but may persist for at least 50 years in jarrah forest soils.
- Findings have been summarised in an information note and presented in detail in a manuscript currently in review for publication in a scientific journal.

*Management implications*

- Engineering solutions, such as covering the ground with harvest waste prior to harvesting, can provide small reductions in soil compaction and disturbance; however on most forest soils, operating machinery in dry conditions and thoughtful planning and management of machine movement across the harvested area offer the simplest solutions for minimising the impact of timber harvesting on soils.
- This work contributed to development and implementation of Appendix 6 of FMP 2004-2013, the Interim Manual of Procedures for the Management of Soils Associated with Timber Harvesting in Native Forests and the draft Soil and Water Conservation Guideline.

*Future directions (next 12-18 months)*

- Finalise publication of manuscript on the adaptive trials of cording.
- Revise and submit for publication a manuscript on the effects of fire on soil carbon.
- 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.*

## Effect of stand density and fertilising 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 (0.2).

*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.

*Aims*

- To determine the effect of stand density and fertiliser on the quantity of seed produced in jarrah forests stands.
- 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 future seed crop of trees from field assessments of these trees.

*Summary of progress (2008/09) and main findings*

- A manuscript based on a study of seed fall in a jarrah thinning experiment at Inglehope east of Dwellingup has been submitted for publication in a scientific journal.
- Twenty-four jarrah trees have been 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 section on seed crop assessment, and in the formulation of Appendix 4, in the silvicultural guidelines – Silvicultural Practice in the Jarrah Forest.

*Future directions (next 12-18 months)*

- Submit manuscript on jarrah seed fall for publication in a scientific journal.
- Assess, fell and strip additional trees to assist Jeff Cargill (PhD student, Edith Cowan University) in developing a tree based seed crop assessment procedure for field application.
- Prepare manuscript on the development of the tree based seed crop assessment procedure and promote the application of this assessment procedure in shelterwood silviculture.

## 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).

*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.

*Aims*

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

*Summary of progress (2008/09) 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.

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## 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).

*Context*

It is important to understand the factors controlling the distribution of invertebrates in the jarrah forest landscape, and whether specialised 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.

*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 (2008/09) and main findings*

There was no activity on this project during 2008/09.

*Management implications*

- Management implications will be identified once analysis of data is completed.
- Preliminary findings indicate that incised valleys are important contributors to invertebrates diversity and that aspect is an important determinant of assemblages across geographical scales of several hundred metres.

*Future directions (next 12-18 months)*

- Update database and analyse the combined dataset.
- Write up and publish in refereed journal.

## Monitoring the northern extent of jarrah leafminer outbreak

SPP# to be allocated

*Team members*

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

*Context*

Jarrah leafminer is an important pest species of jarrah, with significant effects on jarrah biomass production and forest ecosystem health. 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.

*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 (2008/09) and main findings*

- There have been no casual reports of progress northwards of JLM populations since the last survey in 2004. It is likely that an Allee effect, due to high mortality at low population densities, has prevented establishment of populations of JLM in the northern jarrah forest. An Allee effect occurs where invasive populations establishing at new sites suffer mortality high enough to prevent population growth and cause shrinkage of the population such that they are driven towards extinction. Often it is because predators and parasitoids, particularly generalist predators and parasitoids, have unsatiated populations relative to their prey if the prey is at low population densities, but there are other mechanisms too. Understanding Allee dynamics at the low JLM population densities found at the northward invasion front may provide insights into the control of JLM.
- An information sheet describing the ecology and distribution of JLM was prepared.

*Management implications*

Biomass productivity of jarrah and forest ecosystem health 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 is scheduled for October 2009, followed by a report in April 2010.

## Bushfire CRC Project B1.1: Managing fires in forested landscapes in south-west WA

SPP# 2007/003

*Team members*

R Wittkuhn (1.0), L McCaw (0.2), R Robinson (0.2), J Farr (0.2), B Ward (0.1), J Fielder (0.1), G Liddelow (0.2), V Tunsell (0.09), P Van Heurck (0.1), A Wills (0.2).

*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.

*Aims*

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 (2008/09) and main findings*

- Field work has been completed during the last 12 months, including the final biotic surveys and collection of environmental data for inclusion as covariables in the analysis.
- All invertebrate identification has been completed.
- A manuscript on the GIS mapping of fire interval sequences has been published titled 'Fire interval sequences to aid in site selection for biodiversity studies: mapping the fire regime'.
- A manuscript describing the assembly of the fire history data for the Warren Region has been accepted for publication in Conservation Science Western Australia.
- A manuscript describing development of mapping techniques for fire interval and fire season sequences in GIS has been submitted to International Journal of Geographical Information Sciences.
- Presented a paper at the Fire, Environment and Society conference in Adelaide - Assessing the effects of contrasting fire intervals on biodiversity at a landscape scale.
- Currently working on a manuscript that brings together all the results. This manuscript investigates the main question of fire interval sequences and their influence on biota, while analysing the effects of environmental co-variables and the spatial variation across the sites.
- The main findings for all groups suggest that fire interval sequence has little effect on species composition.

*Management implications*

- Provision of scientifically-based guidelines for the appropriate fire frequency in the southeastern jarrah forest will 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 will improve management of fire frequency data.

*Future directions (next 12-18 months)*

- The project is now in write-up stage and drawing to an end. All focus is on writing a manuscript that brings together all the results as described above.
- The findings will be incorporated into a Fire Management Guideline that informs District personnel of the implications of the work.
- Two documents will be prepared for the Bushfire CRC: a final report, detailing all the results and incorporating recommendations for management; and a Fire Note which is a précis of the research outcomes and implications disseminated to all Bushfire CRC researchers and end-users.

## Fire, fragmentation, weeds and the conservation of plant diversity in Wheatbelt Nature Reserves

SPP# 2009/005

*Team members*

C Yates (0.1), C Gosper (1.0); S Prober (External CSIRO).

*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.

*Aims*

- 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 fire interval needed to maintain diversity in plant communities in vegetation remnants?
- How do current fire management methods, such as scrub rolling and burning, affect native plant communities?
- Do fire and other disturbances interact to reduce resistance of eastern wheatbelt plant communities to weed invasion?

*Summary of progress (2008/09) and main findings*

- Comparative analysis of historical fire regimes in the fragmented landscape of the wheatbelt and continuously vegetated areas in the Great Western Woodlands completed. Draft manuscript completed and in review.
- Sampling of vegetation community composition, cover and structure across a time-since-fire gradient in tallerack mallee-heath and mallee communities completed. Measuring vital attributes (plant growth, mortality and fecundity) for select species with contrasting fire life-histories commenced.
- Measuring impacts of scrub rolling and burning on mallee-heath completed. Manuscript accepted for publication in International Journal of Wildland Fire. Second manuscript completed (in review). Information sheet prepared (in review).
- Experiment investigating whether fire and other disturbances interact to reduce resistance of eastern wheatbelt plant communities to weed invasion completed. Draft manuscript completed (in review). Information sheet published.
- Two presentations at forums on ecological fire management in the South Coast Region.

*Management implications*

The research will inform ecological fire management in Wheatbelt Nature Reserves.

*Future directions (next 12-18 months)*

- Complete sampling of vital attributes of key plant species with respect to time since the last fire.
- Complete manuscripts on vegetation community changes with time since fire, and appropriate fire return intervals as derived from the vital attributes of case-study species.
- Presentation at the Society for Restoration Ecology Conference, Perth, August 2009.

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# MARINE SCIENCE

**Program Leader: Chris Simpson**

The role of the Department of Environment and Conservation's (DEC's) Marine Science Program is to ensure Western Australia's marine biodiversity conservation and management programs are based on good science.

## North West Marine Research Inventory

Core Project

*Team members*

C Simpson (0.05), K Waples (0.05).

*Context*

The Commonwealth initiated its northwest marine bioregional planning exercises and, in conjunction with WAMSI 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 was undertaken through Node 3 of WAMSI and, as such, was coordinated by DEC. A project team from CSIRO constructed and populated the database. The complete metadata database was transferred to iVEC so that it could be made available in a searchable format to all users on-line.

*Aims*

To develop a database of information on completed, current and planned marine and coastal research in the north-west marine region (Kalbarri to the Northern Territory) maintained in a format that will make this information available to those that need it with the aim of facilitating a strategic and collaborative approach toward future marine research, planning and management in Northern WA.

*Summary of progress (2008/09) and main findings*

- Project completed in July 2008 including the transfer of the metadata database to an on-line searchable facility through iVEC. The database is under the custodianship of the WAMSI data management officer/iVEC data management officer.
- A final report on the creation of the database and the extent of information that is contained within it was provided to and approved by the steering committee. While the database is not exhaustive, it was able to capture most of the published and much of the grey literature. The project team identified several issues that would need to be addressed for the database to be something other than just a snapshot in time of marine research.
- Staff with marine responsibilities in DEC (i.e. regions, specialist branches) were informed of the finalisation of the inventory and how it could be accessed on-line.
- A paper was presented to the Inter-Departmental Committee to seek their support for further work on implementing and promoting the database until it becomes routinely used and updated by users.

*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)*

Continue to consider and seek means to further promote and maintain the database so that it does not become obsolete, but rather a functional and working database with up to date information.

## Comparative marine biodiversity survey of the Rowley Shoals marine protected areas

SPP# to be allocated

*Team members*

S Wilson (0.05), S Armstrong (0.05), T Holmes (0.05).

*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.

*Aims*

To collect data on the distribution and abundance of key components of marine biodiversity that can be used as indicators of the level of human impact on the reefs of the Rowley Shoals. These data will:

- enable local spatial comparisons between the three Rowley Shoals, which although biologically and geologically similar have differing histories of pressures and management;
- serve as a temporal baseline for longer-term monitoring of trends over time; and
- in combination with comparable datasets from other oceanic shoals off northwestern Australia, enable a timely overview of the regional and global conservation status of these coral reef communities to be undertaken

*Summary of progress (2008/09) and main findings*

- Metadata report and data report completed.
- Keyword-searchable database of WA Museum collections from WA's oceanic shoals completed.
- Photo ID field guides for algae and soft corals completed.

*Management implications*

This work provides initial datasets for monitoring programs being developed for the Rowley Shoals marine protected areas. It will increase public awareness of conservation significance of the Rowley Shoals marine protected areas, and increase awareness in federal agencies (DEWHA, Coastwatch) of need for vigilance against poaching.

*Future directions (next 12-18 months)*

- Data collected during December 2007 field trip to be included as part of the statewide long-term monitoring program currently being developed.
- Complete analysis of data collected.
- Carry out baseline surveys of fish with respect to different management zones.
- 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.
- Further assessment of investigations into causes of apparent coral pathology at the Rowley Shoals.

## Distributions and patterns of major benthic communities of the Montebello/Barrow islands marine protected areas

SPP# to be allocated

*Team member*

K Bancroft (0.10).

*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 and for the ongoing management of the MBIMPA.

*Aims*

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 (2008/09) and main findings*

- A data report was published in January 2009 and a draft technical report is in preparation.
- The present of a significant coral reefs along the eastern side of the Montebello/Barrow islands (~100 km) was confirmed.
- Large *Porites* colonies are a conspicuous component of these reefs and support high abundance and diversity of finfish.
- Preliminary analyses suggest that the abundance and species composition of hermatypic coral communities are significantly influenced by exposure to long-period swell and cyclonic waves.
- The abundance of the common coral predators, *Acanthaster planci* and *Drupella* spp., is low and currently do not appear to be causing extensive damage to live corals on these reefs.
- Provided advice to the Environmental Management Branch on benthic habitat mapping and classification and on the dredging monitoring program for the proposed Gorgon Gas development.

*Management implications*

- The provision of information that assists 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).
- Increased understanding on the condition of the coral reef, reef fish and corallivorous invertebrates communities of the Montebello/ Barrow Islands marine protected areas will improve marine conservation.
- Increased understanding on the distributions of marine benthic communities of the Montebello/ Barrow Islands marine protected areas will improve marine conservation.

*Future directions (next 12-18 months)*

- Finalise and publish the technical report.
- Resurvey the coral communities at established sites within the zone of influence and prior to, during and after the proposed Gorgon dredging operations.

- Quantitatively survey finfish communities at established sites within the zone of influence and prior to, during and after the proposed Gorgon dredging operations.

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

SPP# 2008/002

*Team member*

S Armstrong (0.05)

*Context*

The proposed Dampier Archipelago Marine Park (DAMP) is located off the north-west coast of Western Australia approximately 1650 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.

*Aims*

To monitor targeted finfish abundance and length and rock lobster density such that any differences over time between protected and non-protected zones of the DAMPA can be detected.

*Summary of progress (2008/09) and main findings*

- Preliminary comparisons with an historical AIMS dataset suggests that some target finfish populations have declined significantly between 1993 AIMS survey and the 2006 DEC survey.
- A data report was published in early 2009.
- A draft technical report is in preparation.

*Management implications*

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

*Future directions (next 12-18 months)*

Complete the technical report.

## Monitoring the coral predator, *Drupella cornus,* in Ningaloo Marine Park

SPP# 2008/002

*Team member*

S Armstrong (0.2)

*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. The aim of this project 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 with the last major survey undertaken in April 2008.

*Aims*

To identify trends in *D. cornus* density and cover of associated benthic communities at NMP and MIMMA, by monitoring these variables on a long-term basis.

*Summary of progress (2008/09) and main findings*

- A data report on the 2008 field survey was published and a draft technical report was completed in March 2009.
- A paper was published in the Ningaloo Research Program Progress Report 2008.
- A DEC Science Information Sheet on the study was produced in early 2009.

*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)*

- Finalise and publish the technical report.
- Complete scheduled 2010 *Drupella* survey
- Detailed analysis of *Drupella* coral community data to assess the level of change over the past 20 years.

## Bills Bay reef recovery study and coral spawning observations in Ningaloo Marine Park

SPP# to be allocated

*Team member*

S Armstrong (0.1).

*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 Bills 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 Bills 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, another anoxic event was recorded at Bills Bay. Hundreds of dead fish were washed up along the south eastern shoreline of Bills Bay and coral bleaching was observed along the eastern side of Bills Bay .

*Aims*

To monitor the recovery of corals at Bills Bay from the 1989, and any subsequent, dystrophic crisis events.

*Summary of progress (2008/09) and main findings*

- A field survey was undertaken several months after the anoxic event in mid 2008 to determine the extent of coral mortality. Significant coral mortality was only recorded at the inner (nearshore) sites where average live hard coral cover at these sites was reduced from 55% to 40%. The coral mortality was mainly confined to branching and foliose species such as *Acropora* and *Montipora* spp. while the massive (i.e. 'brain') corals (e.g. favids and poritids) appeared to have been largely unaffected by this event. Similar patterns of coral mortality have been recorded in past surveys of these events.
- A data report documenting the spawning-induced anoxic event in March 2008 was published in early 2009.
- A draft data report documenting the results of the July 2008 survey of the coral communities has been completed.
- A draft technical series has been completed.
- A paper was published in the Ningaloo Research Program Progress Report 2008.
- A DEC Science Information Sheet was produced in early 2009.
- Two Newspaper articles on the study in 2008 were published in the Western Australian and Northern Guardian.

*Management implications*

Surveys of the recovery of the coral reef communities at Bills Bay has been on-going for 20 years and provides valuable insights into the nature and timescales of coral reef recovery in Ningaloo Marine Park. This study is also providing information on the potential response of coral communities in Ningaloo Marine Park to potential climate change impacts.

*Future directions (next 12-18 months)*

- Finalise and publish data report (2).
- Finalise and publish the technical series.
- Undertake and publish a synthesis of all data collected since 1989.

## Mapping the coral reef communities of the Shark Bay Marine Park

SPP# to be allocated

*Team member*

K Bancroft (0.05).

*Context*

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 in some areas of the SBMPA for MPA management.

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 to the marine protected areas.

*Aims*

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

*Summary of progress (2008/09) and main findings*

- A data report was published in January 2009.
- A Landscope article was published in Spring 2008.

*Management implications*

- This project directly addresses Shark Bay Marine Reserves Management Plan 1996-2006 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 will be used in planning and management of the SBMPA.

*Future directions (next 12-18 months)*

Project is completed.

## Summary of historical marine research and monitoring relevant to the Jurien Bay Marine Park

Core project

*Team members*

K Bancroft (0.15), M Rule (0.05), A Kendrick (0.05).

*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. 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.

*Aims*

- To identify all ecological and social research that has been undertaken in the reserve in recent years.
- To analyse these data and provide monitoring data to inform marine park management performance reporting related to the Marine Parks and Reserves Authority (MPRA) audit process.

*Summary of progress (2008/09) and main findings*

- The meta-database has been completed.
- The analysis of historical research and monitoring projects has been finalised and a data report has been published and distributed.

*Management implications*

- This project addresses the JBMP Management Plan 2005-2015 management strategies: 8.4 (1); 8.4 (3); and 8.5 (1).
- It will assist the development of an integrated marine monitoring program in JBMP, the identification of research gaps, and the provision of resource condition data into the MPRA audit process.

*Future directions (next 12-18 months)*

Project is completed.

## Using marine habitats as surrogates to map biodiversity

Core project

*Team members*

K Bancroft (0.2), C Simpson (0.025).

*Context*

Marine habitats are commonly used as surrogates for marine biodiversity to overcome the difficulties and costs of surveying and mapping marine biodiversity directly. Marine benthic habitat mapping exercises have been undertaken in many coastal areas of Western Australia using different methodologies and a range of habitat classification schemes. This approach has produced an array of habitat data of varying quality and utility to DEC. This project aims to develop a framework that guides the progressive collection and interpretation of marine habitat data by regional DEC staff. This approach will facilitate the collection of essential biological information, in a targeted, cost-effective and standardised way, to plan and manage the marine environment of Western Australia, with an initial focus on WA's marine protected areas.

This outputs of this project will service a wider, longer-term Marine Science Program objective of developing a standardised approach to the collection of marine habitat data throughout Western Australia.

*Aims*

- To develop an operational framework for the standardised collection of marine habitat data.
- To develop and include a standardised marine habitat classification scheme within the framework.

*Summary of progress and main findings*

A draft technical report, including a preliminary marine habitat classification scheme, has been completed.

*Management implications*

The project will assist the progressive collection and interpretation of marine habitat data by regional DEC staff in a targeted, cost-effective and standardised way to facilitate the provision of the essential biological information needed to plan and manage marine protected areas in Western Australia.

*Future directions (next 12-18 months)*

Finalise and publish the technical report.

## WAMSI Node 3: Science administration, coordination and integration

Core project.

*Team members*

K Waples (0.7); C Simpson (0.2).

*Context*

In 2005 the State Government 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 (WAMSI) was formed. Research within WAMSI was divided into several themes, each with a lead agency. 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.

At the same time as the development of WAMSI, CSIRO Wealth from Oceans National Research Flagship program established a marine research program within Ningaloo Marine Park called the Ningaloo Collaboration Cluster. This research program is designed to complement the NRP. In addition, AIMS has a number of research projects underway at Ningaloo as part of their core research.

DEC is working together with representatives from the Ningaloo Collaboration Cluster and AIMS to ensure that the planned research takes place so that it meets management needs and to ensure the research is properly integrated and communicated.

The science plan for Node 3 of WAMSI consists of 6 main projects which include up to 20 subprojects. Each project area is led by a different institution/University. Thus the coordination and administration role entails ensuring that all project plans are in place and are running smoothly according to the agreed outputs and timeframes. A Communication Plan has been developed and is being implemented. The role also ensures the transfer and uptake of knowledge generated through the research into management policies, practices and actions. Data management is addressed through all projects to ensure long term storage and custodianship of data generated through research.

Integration of research within Node 3, across WAMSI and between WAMSI and the Ningaloo Collaboration Cluster is managed through the formation of the Ningaloo Research Coordinating Committee (NRCC) and through the following activities which serve to provide forums for sharing information, increasing collaboration between scientist groups and engaging managers and stakeholders:

- Annual Ningaloo Research Symposium.
- WAMSI Operations Group.
- WAMSI cross-nodal symposia and meetings.
- Directed workshops for specific projects (e.g. Management Strategy Evaluation).

*Aims*

- 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.
- To ensure the outputs of research undertaken through the NRP reach target audiences.
- To ensure that knowledge transfer and uptake occurs between scientists, resource managers and decision-makers.
- To ensure the long term storage and custodianship of data from research undertaken through Node 3 of WAMSI.

*Summary of progress (2008/09) and main findings*

- 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.
- WAMSI science review of all Node 3 research projects undertaken in February 2009. All projects were deemed to be producing quality science and to generally be progressing well.
- A progress report of the NRP was produced and published in October 2008. This report included

extended abstracts on all of the Node 3 projects as well as a range of other research underway at Ningaloo and had a specific focus on implications for management from the research. The report was widely distributed and has been made available on both the WAMSI and NRP websites.

- Third Annual Ningaloo Research Symposium- Ningaloo Into the Future: Integrating Science into Management held on 26 and 27 May in Exmouth. The symposium was attended by 100 scientists, managers and interested members of the Exmouth Community. It served a valuable role in promoting the quality science being produced by the NRP and media releases were prepared.
- Ningaloo Student Research Day held on 30 March in Perth. This event was well attended, with 9 presentations made and 17 abstracts included in the proceedings. Interviews with the media were undertaken on the Day.
- A paper was published in the Ningaloo Research Program Progress Report (Oct 2008) on knowledge transfer and the knowledge transfer framework was presented at the 3rd Annual Ningaloo Research Symposium (May 2009) to an audience including both managers and marine scientists in the NRP. A paper was also published in the proceedings of the Symposium.
- Communication Plan developed and made available to scientists, and available on NRP website.

*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.
- The knowledge transfer framework will be further developed and a paper submitted for publication in a peer reviewed journal.

## Conservation of marine turtles in Western Australia

SPP# 1993/040

*Team member*

B Prince (0.75).

*Context*

All marine turtles found in WA waters are listed as threatened species by the Commonwealth of Australia and the State of Western Australia. This long-standing statewide research project aims to provide the critical scientific information for the conservation of marine turtles in Western Australia and the management of human pressures on these animals. Currently turtle research and monitoring in Western Australia is undertaken by DEC Science Division and regional staff, academics and industry consultants with limited standardisation of methods or integration of data. There has also been a significant increase in turtle research in Western Australia by external (to DEC) scientists over the past decade as a result of the potential impacts on these species from industrial development. A comprehensive review of all (internal and external) historical and current turtle research and monitoring is needed to underpin the development of an integrated statewide approach to turtle research and monitoring in Western Australia, as outlined in the recently completed Western Australian turtle recovery plan.

*Aims*

- To gain an adequate understanding of the distribution and abundance of marine turtle populations utilising 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 important 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 (2008/09) and main findings*

- Integrated turtle tagging database developed and provided to regional staff.
- Ongoing study into monitoring of nesting beach temperature profiles.
- Varanus Island turtle population modelling exercise is well advanced. Draft publication in progress.

*Management implications*

Provision of knowledge will allow adequate management of marine turtle stocks.

*Future directions (next 12-18 months)*

Project to be reviewed in 2009/10 as part of a broader review of turtle research and monitoring.

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## Strategy for the development and implementation of an integrated tropical marine research plan: 2010-2015

Core Project

*Team members*

S Wilson (0.30), T Holmes (0.30), C Simpson (0.025), K Friedman (0.025).

*Context*

The research plan will ensure that DEC-funded marine research will be implemented in a strategic and integrated manner, and that appropriate scientific information is available to support DEC's tropical marine protected areas and marine fauna management programs. The document will outline a systematic framework to prioritise marine research, and ensure that research is not needlessly duplicated across biogeographically similar marine reserves or IMCRA bioregions. The local relevance of national and international research will also be assessed. The plan will identify research priorities based on relative conservation significance of the assets, the adequacy of existing knowledge and the relative level of human pressures. Science delivery will be undertaken internally by DEC, through collaborations with external science institutions (e.g. AIMS, CSIRO, universities) and via external contracts.

*Aims*

To develop and progressively implement a strategic and integrated research plan to support WA's tropical marine protected areas and marine fauna management programs.

*Summary of progress (2008/09) and main findings*

- Draft Strategic Plan for the Development and Implementation of Marine Research in the Department of Environment and Conservation, Western Australia 2008-2018 completed for internal review.
- Concept plan for research project *The interaction between climate change and fishing* has been approved and a draft of the scientific project plan has been written and in MSP and external review.
- Concept plan for *Assessing coral disease in WA* has been written and in MSP review.

*Management implications*

Development and implementation of the strategic temperate research strategy will enhance DEC's capacity to plan for and manage WA's marine protected areas and threatened marine fauna.

*Future directions (next 12-18 months)*

- Completion and distribution of the tropical marine research strategy.
- Development and progressive implementation of the research plan.

## Strategy for the development and implementation of an integrated temperate marine research plan: 2010-2015

Core project

*Team members*

A Kendrick (0.55), M Rule (0.30), K Friedman (0.025), C Simpson (0.025).

*Context*

The research plan will ensure that DEC-funded marine research will be implemented in a strategic and integrated manner, and that appropriate scientific information is available to support DEC's tropical marine protected areas and marine fauna management programs. The document will outline a systematic framework to prioritise marine research, and ensure that research is not needlessly duplicated across biogeographically similar marine reserves or IMCRA bioregions. The local relevance of national and international research will also be assessed. The plan will identify research priorities based on relative conservation significance of the assets, the adequacy of existing knowledge and the relative level of human pressures. Science delivery will be undertaken internally by DEC, through collaborations with external science institutions (e.g. AIMS, CSIRO, universities) and via external contracts.

*Aims*

To develop and progressively implement an integrated research plan to support WA's temperate marine protected areas and marine fauna management programs.

*Summary of progress (2008/09) and main findings*

- Draft Strategic Plan for the Development and Implementation of Marine Research in the Department of Environment and Conservation, Western Australia 2010-2015 completed for internal review.
- Concept Plan for research project *The biogeography of mangrove communities in the Shark Bay Marine Park* completed and approved. A Science Project Plan has been drafted and is in review.
- Concept Plan for research project Spatial and temporal patterns in the structure of inter-tidal rocky platform communities of the Shoalwater Islands and Marmion Marine Parks completed and approved. A Science Project Plan has been drafted and is in review.
- A Concept Plan for marine research at the Walpole and Nornalup Inlets Marine Park is in preparation.

*Management implications*

Development and implementation of the strategic temperate research strategy will enhance DEC's capacity to plan for and manage WA's temperate marine protected areas and marine fauna management programs.

*Future directions (next 12-18 months)*

- Completion and distribution of the tropical marine research strategy.
- Development and progressive implementation of the temperate research plan.

## Strategic plan for the development and implementation of a long-term marine monitoring program in Western Australia: 2009-2019

Core project

*Team members*

K Friedman (0.2), C Simpson (0.05).

*Context*

The successful establishment of a long-term, broadscale, institutional marine monitoring program requires a strategic approach to be taken. The strategic plan for the Western Australian Marine Monitoring Program (WAMMP) will outline the rationale, major tasks, timelines and delivery models that are required in the development and implementation of an integrated long-term, statewide marine protected area and threatened marine fauna monitoring program in WA's coastal waters.

*Aims*

To develop a strategic plan to guide the development and implementation of an integrated long-term, statewide marine protected area and threatened marine fauna monitoring program in Western Australia

*Summary of progress (2008/09) and main findings*

- Draft Strategic Plan for the Development and Implementation of The Western Australian Marine Monitoring Program (WAMMP) in the Department of Environment and Conservation, Western Australia 2009-2018 completed for internal review.
- Presentations on the Strategy to Nature Conservation Leaders Meeting and District and Regional Leaders meeting.
- Preliminary discussions with Department of Fisheries (DoF) to integrate departmental marine monitoring programs where appropriate.
- Preliminary discussions with local universities (i.e. UWA, Curtin, ECU, Murdoch.), Commonwealth agencies (e.g. AIMS, CSIRO) and the Australian Marine Science Association about potential future collaborations within the WAMMP.

*Management implications*

The development and implementation of the strategic plan for marine monitoring within DEC's marine conservation programs in an adaptive management context will improve the efficiency and effectiveness of DEC's marine operational management.

*Future directions (next 12-18 months)*

- Publish Strategic Plan.
- Implement actions identified in the strategic plan.

## Implementation of the Western Australian Marine Monitoring Program

Core Project

*Team members*

K Friedman (0.35), C Simpson (0.05), A Kendrick (0.25), S Wilson (0.2), K Bancroft (0.15), S Armstrong (0.2), T Holmes (0.3), M Rule (0.3).

*Context*

The Western Australian Marine Monitoring Program in DEC will adopt a Condition-Pressure-Response (CPR) approach within an adaptive management context and will be delivered primarily through a partnership approach between the Marine Science Program and the Regional Services Division of DEC. Collaborations will also be sought with specialist branches within DEC, other agencies such as the Department of Fisheries, CSIRO and AIMS, local universities, industry and NRM and community groups. The implementation of an integrated and coordinated marine monitoring program will ensure that clear trends on the condition of assets outlined in marine protected area and threatened marine fauna management plans will be available to DEC managers, local and wider community groups and industry. In addition, trends of the human pressures and the effectiveness of management responses will also be made available.

*Aims*

To develop, progressively implement and document strategic and integrated monitoring within WA's marine protected areas and for threatened marine fauna statewide.

*Summary of progress (2008/09) and main findings*

- Eighteen marine ecological asset knowledge reviews are underway and due for completion in late 2009. These asset reviews summarise historical research and monitoring data on the condition of the assets, and information on the trends of human pressures and management responses in relation to each asset.
- Preliminary guidelines have been developed, in collaboration with District Managers and Marine Park Coordinators, to guide the development of a partnership approach to implementing the WAMMP.
- Site visits to the Walpole, Metropolitan, Jurien Bay, Shark Bay and Ningaloo Marine Parks have been completed.
- Fieldwork planning for finfish, mangroves and seagrass has been completed and partially implemented.
- Finfish surveys initiated for the Shoalwater Marine Park.
- Mangrove surveys initiated in Montebello and Shark Bay Marine Parks.
- Seagrass surveys completed in Marmion Marine Park.

*Management implications*

Development and implementation of the long-term monitoring programs will enhance DEC's capacity to plan for and manage WA's marine protected areas and threatened marine fauna more efficiently and effectively.

*Future directions (next 12-18 months)*

- Finalisation of asset knowledge reviews.
- Initiation of asset knowledge reviews for turtles, dugong, sharks and rays, invertebrate communities and microbial communities (i.e. stromatolites),
- Further qualitative modelling to identify key pathways for monitoring,
- Field implementation of monitoring programs.

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# SCIENCE APPLICATIONS

## Program Leader: Paul Gioia

The Science Applications Program focuses on making available online databases of species occurrence, maps of where species have been recorded, and lists of species that have been recorded for any sized area within Western Australia. It also ensures that the research activities undertaken by Science Division staff are based on statistically valid procedures, and the subsequent numerical analyses of the data collected are up-to-date, reliable and accurate.

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### Development of biodiversity indices

SPP# to be allocated

*Team members*

P Gioia (0.05); S Hopper (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 desirable.

*Aims*

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 (2008/09) and main findings*

- Plant species richness and endemism indices are now widely used in a range of planning environments.
- The need to effectively compensate for collector bias to enable comparison with existing results has been identified.
- Data availability for calculating faunal richness has been assessed to be inadequate to yield reliable results, based on current methodologies.

*Management implications*

Species richness and endemism maps are regularly used in DEC planning to improve biodiversity management.

*Future directions (next 12-18 months)*

- Identify recently published methods for compensating for collector effort bias and recalculate species richness and endemism indices using 2003 data and compare with results using most recent data from the Herbarium.
- Identify additional sources for faunal data and reassess data capacity to analyse richness within faunal groups.

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### Provision of authoritative names of WA taxa

Core function.

*Team member*

P Gioia (0.05).

*Context*

DEC, academia and the community rely on authoritative species names to manage species databases. Without authoritative names, the ability to provide and integrate information is substantially minimised. The WA Herbarium is the recognised custodian of the names of Western Australian plants. WACensus, a database system, is the 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.

*Aims*

To provide accurate and timely information on the names of WA taxa to assist in management of species databases within DEC and the wider community.

*Summary of progress (2008/09) and main findings*

- A new faunal census integrated with WACensus names, and utilised in NatureMap, was released in April 2009.
- Integration with WA Museum (WAM) 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 species 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.
- Facilitate future integration of species names databases with WA Museum.

## Online GIS biodiversity mapping (NatureMap)

Core function

*Team member*

P Gioia (0.45), M Choo (0.15).

*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.

*Aims*

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 (2008/09) and main findings*

- A new release of NatureMap was made available in April 2009 that included many enhancements requested at demonstrations and from user feedback.
- NatureMap was recently demonstrated to Corporate Executive and a formal Ministerial launch endorsed for later in 2009.

*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)*

- Provision of enhancements to NatureMap based on feedback from government and industry groups.
- 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.

## 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.

*Aims*

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 (2008/09) and main findings*

- Fauna names are now available as a Max database, and new processes within the WA Museum (WAM) 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 in Max format was released in April 2009.

*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 organised databases through customised forms.

## 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), J Harvey (0.5).

*Context*

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

*Aims*

- To work with other groups within the Avon Catchment Council (ACC) Natural Diversity Program to develop an inventory and information management system of information on current status, condition and major processes threatening the region's natural diversity.
- To collate, analyse and disseminate Avon biodiversity relevant data. This project also aims to 1) develop a strategic conservation plan to direct the Avon Catchment Council's natural diversity funding, 2) develop and maintain monitoring and evaluation across all the Avon's natural diversity projects, 3) examine and report on any gaps in knowledge and/or current natural diversity programs that restrict the ACC from achieving its natural diversity goals and 4) begin addressing the highest priority project and/or knowledge gaps identified in the report. The project has also been extended to develop benchmark descriptions of Wheatbelt vegetation, primarily the woodlands, in order to assess vegetation condition.

*Summary of progress (2008/09) and main findings*

- Version 1.2 of a queryable database for existing vegetation mapping of the Avon Catchment Basin has been produced. This version incorporates enhancements to the user query tool and includes spatial vegetation data for more than 500 reserves and land parcels as well as geo-referenced hard copy vegetation map images sourced for the project. Version 1.2 is planned for initial release on DVD in June to groups working within the Avon. The extent of spatial data in the Version 1.2 application currently represents 17% of remnant vegetation in the Avon Catchment's agricultural zone. The V1.2 Avon Vegetation Database and linked spatial components have been migrated to DEC's corporate spatial repository.
- Completed a number of new datasets for publishing through NatureMap.
- A paper on the current state of monitoring of Declared Rare Flora (DRF) is in preparation.
- Developing metrics for vegetation condition, rehabilitation objectives and evaluating the success of on-ground vegetation protection activities, is now one of the Resource Condition Monitoring (RCM) Significant Species and Communities case studies.
- A monitoring and evaluation framework has been developed for all on-ground projects being delivered to the ACC.
- A report on the project and knowledge gaps that restrict biodiversity conservation in the Avon NRM region has been completed and published.
- A high priority knowledge gap has been identified and is being addressed through the collation of baseline data (monitoring program established), analysis and recommendations made in a report, of which phase one is complete and published.
- Classification of 18 major woodland communities based on analysis of 600 floristic sites, the Avon vegetation mapping data base and expert opinion. Development of vegetation description and condition assessment methodology.
- NatureMap has been updated to incorporate thematic information from the Baselining project and integrated with Avon Natural Diversity Alliance (ANDA) website content.

*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 and the development of vegetation (woodlands) description and condition assessment. Additionally the mapping will be available through NatureMap to provide greater visibility.
- The vegetation description and condition indices will facilitate consistent collection of data for community classification and condition monitoring.

*Future directions (next 12-18 months)*

- Completion of vegetation metadata and input of further vegetation data for Version 1.3 of the Avon vegetation database, and metrics for condition.

- Ensure methods for condition assessment comply with those developed by the RCM Native Vegetation Integrity project. Field test and promote use with DEC staff, NRM and NGO groups.
- Incorporate additional surveys (e.g. by WWF in 2007 and 2008) into the Wheatbelt woodland database and undertake additional surveys and GIS aimed at identifying and describing potential Threatened Ecological Communities.
- Recommendations for future investigations into poorly understood/surveyed communities such as Mallets, gypsum dune communities and Swamp Yate communities will be made.
- Work with other groups within the Avon Catchment Council natural diversity group to provide data support, for example, collaboration with WWF on describing rare and or poorly conserved woodlands.
- Collaboration with Professor Bob Pressey from James Cook University in developing a strategic conservation plan.

## Baselining the Avon NRM Region (Wetlands)

*Team Members*

S Jones (1.0), A Pinder (0.1), D Halliday (0.9), A Leung (0.1), C Francis (1.0), M Collins (0.8), K. Quinlan (0.1), P Gioia (0.05).

*Context*

This project is part of the Natural Diversity Program within the Avon Investment Plan, 2005 (Avon Catchment Council). It is part of the Department's contribution towards the NRM process.

*Aims*

- To map, classify and evaluate the conservation significance at a regional scale (Stage 1) of all basin and granite outcrop wetlands greater than 1 hectare, within the Avon NRM region.
- To develop an on-ground methodology (Stage 3) for evaluating the conservation significance of inundated basin wetlands in the Avon NRM region.
- To conduct a literature review of the potential impacts of agricultural drainage on wetland biota and identify priority areas for future research.

*Summary of progress (2008/09) and main findings*

- Mapping of all basin and granite outcrop wetlands greater than 1 hectare in the Avon NRM region completed and available on NatureMap.
- The regional-scale wetland classification and evaluation methodology was implemented following endorsement by the state Wetlands Coordinating Committee. The classification and evaluations are complete and are available on NatureMap.
- The on-ground wetland evaluation methodology (Stage 3) has been trialed and refined. It has received endorsement from the Wetlands Coordinating Committee and will be made available online (www.avonnaturaldiversity.org).
- The literature review is undergoing final corrections prior to publishing.

*Management implications*

The wetland mapping and evaluation dataset have been made available to local and State governments and will be used to prioritise areas for wetland conservation. It will also be used to strategically plan drainage activities. The on-ground (Stage 3) methodology will be useful for DEC staff in assessing Notice of Intent to Drain proposals. The literature review provides a basis for future project proposals looking at the environmental impact of drainage discharge on wetlands in the region.

*Future directions (next 12-18 months)*

- Produce an information booklet on the fauna of Avon wetlands to improve public awareness and perception of the diversity of fauna in the region, particularly of salt lakes.

- Produce a journal paper on the endemic and diverse invertebrate fauna of salt lakes in the south-west and put it into a global context.

## Management of terrestrial bioprospecting in DEC

Core Function.

*Team members*

R McKellar (0.10), D Coates (0.05), 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.

*Aims*

To manage access to Western Australia's terrestrial flora for bioprospecting purposes in a manner that is efficient and equitable.

*Summary of progress (2008/09) and main findings*

Bioprospect Pty Ltd licence terminated by mutual agreement.

*Management implications*

There is potential for revenues from royalties should drug discovery and development from bioprospecting succeed.

*Future directions (next 12-18 months)*

Respond to further commercial and institutional interest in bioprospecting as it arises.

## Biometrics

Core Function.

*Team member*

M Williams (0.60).

*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 all Science Division's projects are assessed by Program leaders, for relevance to the Department's aims, every project is assessed by the Biometrics staff to ensure that the project design is efficient and has the necessary rigor to answer the research questions posed.

*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 (2008/09) and main findings*

- Scientific paper published.

- Five Science Project / Concept Plans and over 100 manuscripts reviewed for statistical rigour.
- Progressed analysis of FORESTCHECK data for 5-year review.
- Paper on Gray and Kingston forest block bird studies submitted for publication.

*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.

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# PERTH OBSERVATORY

## Program Leader: Dr James Biggs

Perth Observatory, established in 1896, is Australia's oldest continuously operating professional observatory and is the sole remaining State observatory. Perth Observatory is the only significant professional observatory between South Africa and the eastern states of Australia and is sought for collaborations with other astronomy institutions because of its capabilities and its particularly isolated location on the globe.

### Astronomical Outreach and Education

Core Function

*Team members*

J Biggs (0.2), D Frew (0.35), R Martin (0.2), A Verveer (0.3), V Smith (0.2), A Williams (0.25), R. Tonello (0.3), C Mesiku (0.5), G Lowe (0.5), A Taylor (0.4).

*Context*

This core function involves providing services of direct use to the general public and education sector. Its authority is underpinned by active involvement in astronomical research. Some of the projects are long-term worldwide collaborations. There is a significant demand for astronomy education services from many different groups and individuals within the community.

*Aims*

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

*Summary of progress (2008/09)*

- Provision of information and astronomy activities was greatly enhanced throughout 2009 by events that contributed to the 'International Year of Astronomy' (IYA). Perth Observatory actively participated in two of the IYA's worldwide events; 1 January Solar Astronomy Day and the '100 Hours of Astronomy' in April, by taking portable telescopes for both events to King's Park for public viewing. Other activities involved assisting SciTech to stage a 'Space Camp', Observatory staff visited a prominent bookshop to promote astronomy to its customers, and an open air night time lecture was staged in summer.
- The number of visitors attending star viewing nights and day time guided tours totaled 5,586 for the year.
- 44 lectures and presentations were made to university students, primary school students and community groups.
- A new All-Sky Camera was commissioned and provides an internet-accessible, real time, wide-angle view of the night sky visible from Perth Observatory.
- The Observatory's first internet telescope, the Real Astronomy Experience (RAE) Internet Telescope collaboration with the University of California, Berkeley, and the Lawrence Hall of Science, USA), was in regular use by students and scientists world wide. In particular, it was successfully used by physics students at Curtin University as part of their practical astronomy course. Over 30,000 images were acquired.
- The second internet telescope system at Perth Observatory, owned by the Oil Region Astronomical Society and Clarion University, USA, (R-COP) was commissioned by Observatory technical staff and is now in regular use. Its main use is colour imaging but it can also be used for research observations of relatively bright celestial objects. During the financial year nearly 3,000 images were acquired by it.

- Customer satisfaction showed 98 per cent satisfied with their visit or service provided by the Observatory, and 98 per cent were satisfied with the educational quality of the services in which they participated.

Activity Measures

| Activity | 08/09 | 07/08 | 06/07 | 05/06 | 04/05 | 03/04 |
|---|---|---|---|---|---|---|
| Star Viewing Sessions | 102 | 93 | 143 | 183 | 151 | 212 |
| Night Visitors | 4334 | 4 371 | 4 234 | 5 420 | 5 170 | 7 246 |
| Sunday guided tours | 37 | 28 | 30 | 37 | 48 | 80 |
| Daytime guided tours | 1131 | 954 | 1 036 | 1 179 | 1 716 | 2 504 |
| Astronomy Field Nights | 10 | 2 | 16 | 24 | 29 | 18 |
| Field Night attendance | 1846 | 150 | 2045 | 1 244 | 3 293 | 1 524 |
| Lectures and Talks | 44 | 64 | 97 | 47 | 71 | 49 |
| Talk attendance | 1294 | 1 214 | 2 191 | 1 748 | 3 067 | 1 283 |
| Student consultations | 25 | 36 | 56 | 19 | 15 | 17 |
| Customer satisfaction (star viewing and guided tours, %) | 98 | 96 | 98 | 98 | 98 | 98 |
| Astronomy awareness raised (%) | 100 | 96 | 98 | 97 | 97 | 98 |
| Educational quality (%) | 98 | 96 | 97 | 96 | 98 | 98 |

*Management implications*

The substantial visitor numbers, together with sound customer satisfaction evaluations, indicates hat there is continuing strong demand for these services from the Observatory.

*Future directions*

- Continue to participate in International Year of Astronomy activities in 2009.
- Adequately house the 76-cm aperture telescope - the largest telescope regularly used for public star viewing in the Southern Hemisphere.
- Develop educational worksheets for visiting school groups.

## Astronomical Information Services

Core function

*Team members*

J Biggs (0.2), D Frew (0.2), R Martin (0.1), A Verveer (0.1), V Smith (0.2), A Williams (0.1), R Tonello (0.1), C Mesiku (0.3), G Lowe (0.3), A Taylor (0.2).

*Context*

This core function involves providing information of direct use to various groups within the community. Its authority is underpinned by active involvement in astronomical research. Some of the projects are long-term worldwide collaborations. There is a significant demand for astronomical information from many different groups and individuals within the community.

*Aims*

To provide relevant and timely astronomical information.

*Summary of progress (2008/09)*

- Two publications of an information/education nature were produced, as well as the 2009 Western Australian Astronomical Almanac and CD.
- An exhibition of astronomical photographs was developed and is currently touring metropolitan and

rural cultural centres as part of the Observatory's contribution to 'International Year of Astronomy' (IYA) mentioned above.

- There were over 323 000 'page views' of the Observatory's website and an additional 8% more pages were added during the year.
- Another novel outreach project was the operation of a simple radio telescope "RADIO JOVE" in collaboration with a private individual.

Activity Measures

| Activity | 08/09 | 07/08 | 06/07 | 05/06 | 04/05 | 03/04 | 02/03 |
|---|---|---|---|---|---|---|---|
| Telephone enquiries | 4 817** | 9 858 | 13 348 | 14 655 | 11 516 | 19 095 | 9 872 |
| Information line | 1 031 | 2 179 | 3 413 | 2 935 | 1 996 | 3 416 | 1 462 |
| Email enquiries | 769 | 615 | 777 | 447 | 543 | 519 | 562 |
| Consultations | 38 | 47 | 56 | 36 | 20 | 20 | 86 |
| Newspaper, radio & TV | 129 | 175 | 201 | 161 | 105 | 147 | 136 |
| www page views (000s)* | 323 | 404 | 1 519 | 880 | 709 | 2 200 | 1 116 |
| Positive responses to 'quality' questions in customer surveys (%) | 98 | 99 | 98 | 98 | 98 | 98 | 98 |
| Satisfaction of information requests as they occur (%) | 98 | 97 | 95 | 95 | 98 | 92 | 98 |

*From 07/08, 'page views' rather than raw 'hits' have been recorded as a performance indicator because this better reflects the actual use of a website.

** Affected by a long duration equipment malfunction.

*Management implications*

The sustained level of information service provision, together with sound customer satisfaction evaluations, indicates that there is continuing strong demand for these services from the Observatory.

*Future directions*

- From early in 2010 the photographic exhibition will be on permanent display at the Observatory. The Observatory's display room will be further updated with improved captions and the development of a self-guided tour.
- Promotion, and training students in the use, of the RAE and R-COP Internet telescopes.
- Make the output of the "RADIO JOVE" radio telescope available on the Observatory's website and thus provide a view of the Universe complementary to that available from optical telescopes.

## 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).

*Context*

This SPP involves a long-term worldwide collaboration involving the study of variable stars.

*Aims*

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

*Summary of progress (2009/09) and main findings*

- Monitoring observations of the central stars of planetary nebulae continued on the PLAT. The observation of 30 central planetary nebula stars has found 6 stars that are variable. Two refereed papers are in preparation.
- The RAE internet telescope was used to intensively monitor Eta-Carina during the 2009 spectroscopic event, and a refereed paper concerning this is in preparation.

*Management implications*

The Eta-Carina observing program demonstrates that the 14 inch RAE internet telescope is able to make accurate photometric observations that can be used for research.

*Future directions*

Participation in variable star monitoring programs will continue for 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).

*Context*

This SPP involves a long-term collaboration with US astronomers in the study of comets.

*Aims*

- 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.

*Summary of progress (2008/09) and main findings*

This SPP was dormant in 2008/2009 owing to the lack of suitable targets.

*Management implications*

Observations of comets will facilitate a comparison between the various cometary families and build a database of cometary properties.

*Future directions*

- Installation of an automated focuser for the PLAT Telescope will facilitate an increased number of observations.
- Partners at Lowell Observatory will undertake high priority observations as opportunities concerning suitable comets arise.

## 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).

*Context*

Suitable targets are imaged and processed as appropriate.

*Aims*

- 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 (2008/09) and main findings*

- A refereed paper on the planetary nebula NGC248 precludes the planetary nebula's membership to the open cluster M46. Five hundred and eighty six radial velocity measurements, centred on the open cluster M46 and the planetary nebular NGC 2438, were used to find a 30 $kms^{-1}$ difference between the velocity of the cluster and velocity of the nebula.
- A second refereed paper researches the interaction between an existing planetary nebular and the Nova V458 Vul. The derived distance to the nebula is 13 kpc, the mass of the nebula is 0.2 solar masses and its age is estimated to be 14,000 years. Two possible evolutionary scenarios are discussed, at least one these scenarios would produce a type Ia supernova.

*Management implications*

- The planetary nebula NGC 248 was shown not to be a member of the open star cluster M46 and thus both objects have evolved independently.
- The nova V458 Vul is shown to have occurred in a previously unknown planetary nebula.

*Future directions*

- Suitable targets will be observed as time and resources permit.
- Future observations will be conducted using the PLAT, and, RAE and R-COP internet telescopes.

## Astrometry of minor planets, comets and targets of opportunity

SPP# 1998/012

*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 (0.04), C Mesiku (0.04).

*Context*

This SPP involves a long-term worldwide collaboration to track and discover asteroids and comets. Targets of opportunity are also observed as appropriate.

*Aims*

- 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 specialised 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 (2008/09) and main findings*

The positions derived from observations of 11 asteroids and 11 newly discovered comets were forwarded to the Minor Planet Center at Harvard University.

*Management implications*

Astrometric positions are supplied to the Minor Planet Center to refine the orbits of selected asteroids and comets.

*Future directions*

Monitoring of NEOs and comets 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).

*Context*

This SPP involves a worldwide collaboration – PLANET, with 22 full and nine associate members, affiliated with 20 institutions in 10 countries. The project uses the gravitational microlensing effect to gain information about our galaxy, its stars and their planetary companions. 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).

*Aims*

- To use precise light curve measurements in order to characterise 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.

*Summary of progress (2008/09) 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 so that targets can be observed for 24 hours a day, 7 days a week. Members anywhere in the world are able to adjust target selection and sample rates to optimise coverage of ongoing anomalies. Perth Observatory, although having the smallest telescope in the collaboration, is the only site with full automation of both telescope and data reduction - most other telescopes require an observer to be present all night, every night, and reduce images manually as they select targets and control the telescope. Three peer reviewed papers were published this year.

*Management implications*

- While there are several techniques for finding extrasolar planets, microlensing searches an entirely different region of parameter-space, with different selection biases, and forms a perfect complement the radial velocity technique to help determine planet formation mechanisms and the statistics of planetary systems.
- The microlens event OGLE-2007-BLG-472 was used to demonstrate a new statistical method for obtaining the best fitting set of physical parameters for a given set of microlens brightness observations.
- Microlens OGLE-2007-BLG-224 was a short duration, high magnification event that also had a high angular speed across the sky. These properties allowed a technique for determining distance within the Solar System to be used to measure the mass, distance and transverse velocity of a nearby star.

*Future directions*

- Three more papers are in press, and several more in preparation.
- The May-September 2009 'bulge season' observing is underway.

## 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).

*Context*

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

*Aims*

- To contribute to the broader study of supernovae by employing methodical search techniques to detect supernovae at early stages of their evolution.
- To make an independent determination of the supernovae rates within late spiral galaxies.
- To do additional research on the supernovae found. For example, collect photometric light curves of supernovae discovered by Perth Automated Supernova Search.
- The Perth Automated Supernova Search is a search for extra-galactic supernovae in low redshift spiral galaxies and uses the PLAT at Perth Observatory.

*Summary of progress (2008/09) and main findings*

- A refereed paper on SN1999ga has been accepted for publication. This paper shows that SN1999ga is a rare, and little researched, low luminosity linearly declining type II supernova.
- One supernova was discovered: SN2009y.
- Photometry of SN2008cn was collected on 20 nights and a paper is in preparation.
- Two other supernovae were recovered: SN2008fp and SN2008gz.
- A poster paper on SN2004s was presented at the ASA conference in Perth.
- The PLAT responded to three gamma ray bursts, no optical counterparts to the events were observed.
- A prototype of computer code to automatically focus the PLAT was produced.

*Management implications*

- The work has demonstrated that SN1999ga is an example of a rare and little observed supernova and the published light curve will provide useful data for mathematical modelling.
- The ability to automatically focus the code improves the consistency of the data collected by the Perth Lowell Automated Telescope.

*Future directions*

Increase the number of supernovae that are photometrically monitored.

## Astronomical evaluation of sites in WA

SPP# 2000/006

*Team members*

J Biggs (0.06), 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).

*Context*

This SPP involves evaluation of various sites regarding their suitability for astronomical observations.

*Aims*

Testing appropriate Western Australian sites regarding their suitability for astronomical observations.

*Summary of progress (2008/09) and main findings*

This SPP was dormant in 2008/2009.

*Management implications*

Determining the suitability of sites for astronomical observations will provide information necessary for the planning of future facilities.

*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 appropriate.

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# STUDENT PROJECTS PROGRESS REPORT

The following reports were supplied.

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**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:

- inventory the regional beetle fauna and locate short range endemic species;
- monitor the appropriate spacing between pitfall traps to most effectively analyse the local beetle fauna;
- collect litter samples to compare the fire impact on the beetle fauna of this microhabitat;
- determine the reliability of using morphospecies within the beetle families; and
- 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 2009. To date over 15 000 arthropod specimens have been sorted of which 20.2% are beetle species (344 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. London block has since been mosaic burnt in January 2006 and December 2008, when fuel loadings were heavier. These mosaic burns have resulted in approximately 20% and 55% of London block being burnt, each with a diversity of fire intensities and an increasingly patchy pattern of unburnt post-fire ages. 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 130 beetle morphospecies collected only from mosaic burnt sites in comparison to 91 beetle morphospecies only from wildfire burnt sites, for the same sample dates.

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**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 has been completed and the student is expected to complete the write-up December 2009, with her "defence" in March 2010. A number of papers are currently being drafted and presentation of certain aspects of the work was undertaken at two international conferences last year.

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**Scientist:** **D Algar**

*Student:* *K Koch*

*Project title*

**Genetic diversity and phylogeography of Australian cats (a work in progress)**

*Progress report*

Cats are well studied in terms of behaviour, domestication, genetics and genomics across most continents, but we lack information on the Australian feral cat populations. In particular hardly any genetic data are available to determine the origin and secondary invasion, the population structure and sizes of Australian feral cats. In order to fill this gap and to provide the necessary information for effective monitoring and control of cats, Katrin plans to assess the genetic variation of several mainland and island populations.

Katrin has only recently commenced this Ph D thesis.

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**Scientist:** **AH Burbidge**

*Student:* *C Jackson*

*Project title*

**Damage to canola crops by Carnaby's Black-Cockatoo**

*Progress report*

Carnaby's Black-Cockatoo is an endangered species that sometimes feeds in commercial crops, and this behaviour may lead to persecution by some farmers. Field work for this project is now complete, analysis and writing up are currently being undertaken, and the thesis will be submitted in mid-2009. The thesis has established a protocol for identifying, and quantifying canola crop damage by cockatoos. It has been established that damage by Carnaby's Black-Cockatoos is minimal, and is usually limited to the edge of the crop. Current analyses will identify the relative importance of selected environmental factors that may be correlated with levels of crop damage. This should lead to management recommendations to minimise crop damage and reduce potential threats to cockatoos.

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**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-west Western Australia and has been widely grown and utilised. 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 been assessed for 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 parent trees. The mean salt tolerance of the progeny was increased relative to that of the original trees in the trial. A paper detailing the genetic diversity in the family trial and the cross pollinated progeny trial has been submitted for publication.

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**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 utilisation as a forage crop. This project will assess risks of gene flow and hybridisation between *C. tenax* and other species.

Microsatellite loci have been developed for *Cullen* and eight loci variable in both *C. australasicum* and *C. tenax* have been selected. A paper detailing the microsatellite markers has been accepted for publication in Conservation Genetics. Genotypes of field plot plants and their progeny have been assayed for the microsatellite loci and are currently being analysed. The data will be used to estimate rates of outcrossing in *C. australasicum* as well as rates of hybridisation between *C. australasicum* and *C. cinereum*, *C. discolor*, *C. pallidum* and *C. patens*. Molecular phylogenetic relationships between these species will also be examined.

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**Scientist:** **M Byrne**

*Student:* *R Thavornkanlapachai*

*Project title*

**Pollen dispersal in *Banksia nivea* ssp. *uliginosa***

*Progress report*

This project will investigate the extent and pattern of pollen dispersal among populations of *Banksia nivea*, a rare species restricted to a specialised environment, the ironstone habitat around Busselton. The project will determine the pattern of pollen dispersal by paternity assignment for a sample of seed produced in selected populations. The source of the paternal contribution to the seed either from within the population or from another population will be determined through genotyping all adult plants in the populations and assaying the genotypes of a sample of seed. The genotypes of the plants and the seedlings will be analysed to determine the source of paternity in the seedlings. The level of outcrossing and pollen immigration will be correlated with other variables such as population size and population isolation. Reproductive biology parameters are also being investigated and seed production over the last three years and seed germination will be determined for eight populations.

Leaf and seed samples have been collected from target populations. Seed has been extracted from cones representing three years mating and viable, inviable and predated seed have been counted. DNA has been extracted from the adult plants and genotyping is currently being carried out. Seed has been germinated and germination rates determined. Seedlings are being grown for DNA extraction. The genotypes of the seedlings will be determined and their paternity assigned. Paternity data will be analysed to determine pollen dispersal patterns.

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**Scientist:** **M Byrne**

*Student:* *A Shah*

*Project title*

**Genetic diversity and differentiation among subspecies of *Banksia nivea***

*Progress report*

*Banksia nivea*, commonly known as Swamp honeypot, consists of both a rare and common

subspecies. The rare subspecies, *B. nivea* subsp. *ulignosa* is currently listed as critically endangered and occurs in a number of populations in the Busselton region that are separated from a few populations on the Scott River Plain by the Whicher Range. The common subspecies *B. nivea* subsp. *nivea* has a widespread distribution that ranges from Geraldton to Esperance. A third proposed subspecies *B. nivea* subsp. *morangup* is restricted to a single population near Toodyay. This project will investigate the genetic diversity within populations of the subspecies and the genetic differentiation among the subspecies.

Leaf samples have been collected from 20 plants from each of 10 populations of subsp. *uliginosa*, five populations of subsp. *nivea* and the single known population of the proposed subsp. Morangup. DNA has been extracted from samples of plants from eight populations around Busselton and genotypes of these samples have been assayed for 12 microsatellite loci. The remainder of the samples will have DNA extractions carried out and their genotypes determined. The genotype data set will then be analysed to determine levels of genetic diversity and differentiation.

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**Scientist:** **P de Tores**

*Student:* *J Clarke*

*Project title*

**Translocation outcomes for the western ringtail possum (*Pseudocheirus occidentalis*) in the presence of the common brushtail possum (*Trichosurus vulpecula*): Health, survivorship and habitat use**

*Progress report*

This project investigated the health, survival and habitat use of *Pseudocheirus occidentalis* translocated from the Busselton region into 1080-baited and unbaited sites at Leschenault Peninsula and Yalgorup National Park during 2006-08. *Trichosurus vulpecula* resident at the sites were similarly studied. The work is currently in the write-up stage and will be completed by late 2009.

Predation was the ultimate factor limiting translocation success of *P. occidentalis* in this study. Predator species included foxes, cats, pythons and raptors. Survival also appeared to be adversely affected by *T. vulpecula* population sizes and aspects of habitat quality, particularly nutrition. Although both possum species were clinically healthy and disease-free, there was a relationship between pre-translocation white blood cell counts and post-translocation survival for *P. occidentalis*, which suggests that low-level inflammatory processes or stress responses were proximate factors influencing susceptibility to predation. Longer term survival was a function of temperature and rainfall, with drought conditions appearing particularly deleterious for *P. occidentalis*. Establishment and maintenance of viable translocated populations of *P. occidentalis* requires more effective control of exotic predators. However, even then, the carrying capacity of the field sites may be too low for long term population stability, especially in the face of climate change. Preservation of existing habitat in and around Busselton is paramount.

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**Scientist:** **P de Tores**

*Student:* *H Grimm (nee 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. Fieldwork, completed between November 2006 and January 2009, involved data collection for examination of population density, home range size and spatial arrangement, habitat use, survivorship and causes of mortality, and physiological parameters and indication of exposure to infectious disease.

Data analysis is currently underway. The application of analytical techniques that are novel for these species will produce important advances in knowledge of their ecology, particularly for the threatened ngwayir. It is expected that full results will be published in 2010.

**Scientist:** **P de Tores**

*Student:* *G 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 46 South west carpet pythons (*Morelia spilota imbricata*) with radio transmitters (Holohil®) designed specifically for use in snakes into their coelomic cavities under general anaesthesia. Over the course of three years, 46 pythons were monitored through 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 selection, use of landscape (home range), diet, body weight and reproductive condition. Thermal biology data on a number of pythons was collected with the use of implanted temperature loggers (iButtons®) to gain hourly python body temperatures and external loggers (HOBOs®) for ambient temperature recordings. Haematological characteristics of the pythons was also collected and analysed, in most cases prior to implanting, at 4-6 months post implanting and upon removal of the radio transmitter. All field work is now complete and all study pythons have had radio transmitters removed and pythons were released back to their point of capture during November 2008. Data collected over this period will provide important information to the scientific community on this particular subspecies of carpet python through a series of planned manuscripts which will be submitted to scientific journals. This research will be completed by the end of 2009.

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**Scientist:** **P de Tores**

*Student:* *J Cruz*

*Project title*

**Ecology of the Common brushtail possum in the northern jarrah forest in relation to predation and resource availability**

*Progress report*

The western subspecies of the Common brushtail possum (*Trichosurus vulpecula hypoleucus*) or koomal, has declined in abundance and spread and is currently listed as "near threatened". This PhD project aims to determine the effects of resource availability and predation by foxes and cats on koomal demographics and behaviour in the northern jarrah forest. Furthermore, the project will provide information on the koomal diet and general ecology.

Fieldwork was completed in autumn 2009. Trapping was conducted seasonally at ten sites to provide details on koomal abundance, reproductive output, morphometrics and scats for dietary analysis. The sites were also sampled to determine food and den availability and predator activity. The identification of plant specimens and invertebrates collected as measures of food availability has commenced and is expected to be completed by July of 2009. The dietary analysis will commence in July and is due to be completed by August of 2009. Data analysis and write-up are expected to be completed by mid-2010.

The habitat use of the koomal was assessed at three sites using a combination of radio-tracking and spool-and-line tracking. A total of nineteen koomal provided enough data for home-range studies. Thirty six koomal were fitted with spools to obtain data on their micro-habitat use.

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**Scientist:** **P de Tores (Peter Spencer, Murdoch University)**

*Student:* *K Wilson*

*Project title*

**Quantifying the genetic effects of habitat fragmentation on the western ringtail possum (*Pseudocheirus occidentalis*) in south-west Western Australia**

*Progress report*

Mitochondrial DNA analysis revealed no phylogeographic structuring between populations from different geographic regions within WA (Upper Warren, Busselton and Bunbury) and indicates these

populations were historically connected. However, the high level of sequence divergence between the western ringtail possum and the common ringtail possum (*Pseudocheirus peregrinus*) from eastern Australia suggests they are two distinct species.

Fourteen polymorphic microsatellite loci were isolated to investigate the genetic population structure and patterns of genetic diversity within Western Australian populations of *P. occidentalis* from the Upper Warren, Bunbury and Busselton regions. The microsatellite analysis revealed a considerable level of population structuring, with three discrete populations existing as little as 30km apart within the Bunbury/Busselton area. Population structure inferred at least three populations, named on their broad geographical origins Busselton, Gelorup and Upper Warren.

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**Scientist:** **J Farr**

*Student:* *K Ironside*

*Project title*

**Trophic dynamics of predatory invertebrates in jarrah forests of differing fire history**

*Progress report*

This project proposes to use stable isotopes to investigate how historical fire regimes have influenced the trophic relationships of invertebrate communities in jarrah forest ecosystems. It tests the hypothesis that frequent fire increases the incidence of intraguild predation in litter dwelling predatory invertebrate groups. To achieve this, the effect of contrasting fire interval patterns and fire frequency on litter the dwellling invertebrate community as a whole will also be investigated. An inventory of invertebrate fauna will be established to determine if species richness and abundance differ within or between fire treatments. Specimens will be categorised into their respective trophic groups to determine if fire has changed the trophic structure of the communities.

Field work was completed in April 2009 and specimens have been identified to morphospecies taxonomic level. Specimens have been prepared for stable isotope analysis to commence in June 2009.

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**Scientist:** **J Farr**

*Student:* *S Danti*

*Project title*

**The influence of two different silvicultural treatments on coarse woody debris and saproxylic beetle assemblages in southern forests of Western Australia**

*Progress report*

The aim of this project is to examine the effect of two silvicultural treatments on the habitat value of coarse woody debris for saproxylic (wood dependent) beetle assemblages in the jarrah forest. It investigates the influence of gap release and shelterwood treatments on CWD volume, diameter and decay stage in relation to saproxylic beetle composition and trophic guild assemblage. In addition, the project endeavoured to gain a better understanding on the natural dynamics of coarse woody debris in south-west Western Australia. Work at Kingston forest block in plots established for the FORESTCHECK project found that species richness was highest for Hymenoptera order with 38 species. Other orders with high species richness included Coleoptera (32 species) and Diptera (26 species). Results suggest there is no treatment effect for invertebrate assemblages although there was a problem with treatment replication. Stephen submitted his thesis in December 2008.

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**Scientist:** **JA Friend**

*Student:* *J Pridham*

*Project title*

**Finding a dietary surrogate for the Critically Endangered Gilbert's potoroo *Potorous gilbertii***

*Progress report*

One of the primary strategies to promote the conservation of the potoroo is to establish translocated colonies. A requirement for the potoroo's habitat is significant hypogeal fungi which comprises 90% of its diet. Mycophagy is a trait shared with three more common mammals also found in the potoroo's

habitat; bush rat *Rattus fuscipes*, quokka *Setonix brachyurus* and quenda *Isoodon obesulus*. Scats from live captured animals at three sites will be microscopically examined to ascertain which has the most similar fungal diet to the potoroo and to determine if one (or more) of the more common species can be used as an indicator of food resource abundance for Gilbert's potoroo to assess future translocation sites. Survey trapping is to undertaken three times per year; March, July and November.

To date, samples have been obtained from the November 2008 survey at Mt Gardner, March 2009 survey at Mt Gardner, Water Corp Reserve at Two Peoples Bay and Normans Beach. Sampling for July 2009 at all three sites is currently being undertaken.

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**Scientist:** **JA Friend**

*Student:* *J Austen*

*Project title*

### Characterisation of a novel Western Australian *Trypanosoma* species isolated from native marsupials

*Progress report*

Recently, a novel *Trypanosoma* sp. was identified in blood smears obtained from several marsupials inhabiting Two Peoples Bay, including the critically endangered Gilbert's potoroo (*Potorous gilbertii*), the southern brown bandicoot (*Isoodon obesulus*) and the quokka (*Setonix brachyurus*). There is limited information on the ecology and biology of these haemoparasites and their impact on the health of Australian animals. This study will involve an in-depth study into the ecology, biology, genetics and pathogenicity of this novel parasite and will enhance future recovery plans for the Gilberts potoroo.

To date the morphology has been analysed and statistical analysis performed on the various parameters of the trypomastigote life-cycle stage to aid in characterisation. Both scanning electron microscopy and immunofluorecence studies on the novel trypanosome have also been completed. Cultivation of the trypanosomes using liquid media and a variety of different cell lines as well as the screening of blood smears to determine the prevalence of these novel trypanosomes is ongoing. Amplification and sequencing of most of the 18s rRNA gene and the GAPDH gene has been performed allowing phylogenetic analysis of these sequences to be compared to other known *Trypanosoma* species. Potential ectoparasite vectors have also been collected and identified to species level. Histological studies are currently under way to help determine if trypanosomes are present within the mid gut region of potential vectors.

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**Scientist:** **T Macfarlane**

*Student:* *U Sirisena*

*Project title*

### Systematic studies on *Thysanotus*

*Progress report*

*Thysanotus* (common name Fringed Lilies) is a genus of approximately 50 species of plants, mostly in southwestern WA and including a number of threatened species. Whilst there has been extensive taxonomy carried out on the species, little is known of the inter-relationships of the species, their evolutionary history in relation to their distribution in eastern, western, tropical and inland Australia and the few species that extend outside of Australia. There is also an issue as to how the two species of the related genus *Murchisonia* relate to *Thysanotus*. This project is investigating the relationships of these species using morphology, anatomy and DNA sequence analysis.

The combined analysis of the data shows a reasonably robust structure of related groups of species which correlate with morphological characters such as rootstock type, anther number and habit, though less clearly with geography, indicating a complex history of migrations. The two species of *Murchisonia* are included in *Thysanotus*, and are well separated from each other, the twining species being placed with the 2-3 twining species of *Thysanotus*. Special attention has been paid to stem anatomy, which has not been extensively studied previously, and this has revealed features or tissue patterns that are often characteristic of species. Seed morphology and seed coat surface fine structure has also been examined and has proven to be useful systematically.

One paper has been submitted describing a new species from WA that was recognised during field work for this project, and another paper has been drafted for a new species arising from re-examination of the widespread eastern species *T. juncifolius*. The results of the seed study have also been drafted

for publication. One issue with *Thysanotus* is that plants can often not be identified accurately without open flowers and a knowledge of their rootstock, which are often not available when plants need to be identified. The anatomy and DNA results offer the prospect of better tools for the identification of incomplete specimens.

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**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 monitoring have also commenced following shelterwood burns conducted at Dale and Palmer blocks in spring 2007, Wilga and Helms blocks in autumn 2008, and Morgan and Chalk blocks in spring 2008. Further investigation of seed crop assessment has been undertaken during 2008/09 including direct inspection of seed crops within intact tree canopies at Morgan block from an elevated work platform. Four transects were established to monitor survival of jarrah seedlings that emerged following an autumn 2008 burn at Stockyard block in the eastern forest; transects are located in a stand treated with shelterwood harvesting in 1997 and sampled as part of the FORESTCHECK monitoring project. Survival from December 2008 until June 2009 was good (>70 per cent) despite dry conditions persisting into late autumn.

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**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 manuscript describing the use of *Callitris preissii* stem sections and cores for dendrochronology has been accepted for publication in *Dendrochronologia*. Analysis of fire activity in relation to climatic data has demonstrated that large fire events are associated with extreme drought years during the fire year, preceded by significantly wet and cool conditions during the preceding year. The probability of fire occurrence differs significantly between major vegetation associations ranging from 47 years in

shrublands, 63 years in mallee and over 400 years in open eucalypt woodlands. Manuscripts describing climatic and vegetation influences on fire patterns are being prepared for submission to journals during 2009.

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**Scientist: L McCaw**

*Student: J 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.

Two experimental fires have been completed at Tallarook in central Victoria to provide comparative data on fuel consumption for south-eastern Australia.

An extensive fuel consumption data set gathered in conjunction with Project Aquarius fire experiments in Western Australia during 2003 has been validated in readiness for analysis.

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**Scientist: K Morris**

*Student N Willers*

*Project Title:*

**Deslorelin implants prevent reproduction in female black-flanked rock-wallabies (*Petrogale lateralis lateralis*) in Western Australia**

*Progress Report*

In a fragmented landscape, isolated populations of black-flanked rock wallabies can increase to the point where they generate problems including crop damage and overgrazing of vegetation in the reserves where they occur, with obvious risks for population persistence. Fertility control using hormone implants has potential for managing population size in these situations. We tested whether deslorelin, a superagonist of gonadotropin-releasing hormone (GnRH), suppresses reproduction in black-flanked rock wallabies.

In autumn 2007 we synchronised the reproduction of 59 free-living adult female rock wallabies by removing pouch young (RPY) at Mt Caroline Nature Reserve (wheatbelt, W.A.). We treated females with 4.7 (n=19) or 9.4 mg (n=20) implants of deslorelin, or a placebo (n = 20). Females were monitored for 24 months for the presence of new pouch young. We challenged females with GnRH (2.5 µg/kg im) on six occasions over the two years as a second measure of suppression of reproduction. Deslorelin suppresses pituitary function and we expected that suppressed females would show no hormonal response but control females would show a rise in Luteinising Hormone (LH) following a GnRH challenge. Following RPY, diapaused blastocysts reactivated in 5/15 recaptured females treated with 9.4 mg and carried through to weaning. Subsequently, none of these five, or any of the 40 other recaptured wallabies treated with deslorelin, at either dose, conceived again for the next 24 months. Wallabies treated with a placebo responded to the GnRH challenge with a marked rise in plasma concentrations of LH and maintained an average reproductive rate of over 90 per cent throughout the study. Deslorelin treated females did not respond to the GnRH challenge.

The results demonstrate that deslorelin blocks the hypothalamic-pituitary-gonadal axis and inhibits reproduction for at least 24 months in female black-flanked rock wallabies. This makes it an attractive tool for managing instances of overabundance.

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**Scientist: I Radford**

*Student: A Cook*

*Project title*

**Can mosaic burning protect northern quolls from severe wildfires in the north Kimberley?**

*Progress Report*

This project forms part of the major research and monitoring program being conducted in the north Kimberley region, which is a detailed investigation of density, fecundity and survivorship of critical weight range (CWR) mammals in relation to current fire regimes. The study is being conducted at the Mitchell Plateau in the north Kimberley where large areas frequently experience broad-scale intense wildfires, with some small areas being managed or protected where a small-scale fire mosaic results. This student project is intended to gather information on habitat use and home range movements of northern quolls (*Dasyurus hallucatus*) as a component of the main research project. The northern quoll is a CWR species that remains abundant in several areas of the north Kimberley and are predominant in the abovementioned capture-release monitoring program. They are a suitable species for detailed investigation of landscape/habitat and resource use in the context of fire mosaics as they are a major native predator ranging over relatively large territories.

A preliminary field trip was conducted during August/September 2008 to establish monitoring sites in savannah woodlands adjacent to studies sites currently being monitored in rocky habitats. A capture release program was commenced to investigate the abundance and composition of small mammal communities, in particular quolls and potential prey species, and to determine the landscape use and movements of quolls between habitat types. Results of preliminary trapping indicated that a small number of quolls initially trapped in rocky habitats were using the adjacent woodlands for foraging, and that a number of prey species were present. However low capture rates limited the conclusions that could be drawn from the data. A second field trip was conducted for the purpose of radio collaring quolls and recording home range movements. Sixteen adult quolls were radio collared at sites within rocky habitats subjected to both fine-grained mosaic burning regimes and frequent large-scale fires. A total of 143 individual den sites were recorded. Number of dens for individual quolls ranged from one to 17. One individual travelled a distance of 1.6km between den sites in one night. Home ranges are being mapped based on den site locations and will be related to productivity and dietary resource abundance data recorded for each study site.

A further field trip at the end of the dry season (August/September) will investigate seasonal differences in resource availability, habitat use and home range size.

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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*

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 for 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.

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**Scientist:** **C Simpson**

*Student:* *B Fowles*

*Project title*

**Shifting baselines in commercial and recreational fisheries at Ningaloo Marine Park**

*Progress report*

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.

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**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*

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.

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**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 through DNA sequencing that many current and historical isolates of *Phytophthora* from the south-west of Western Australia, previously classified as known morphospecies, are actually unnamed taxa. There are now known to be at least 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 characterise 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*. .

The phylogenetic component of the project is complete, and has reinforced the standing of each of these taxa as distinct entities. Furthermore, it has become apparent that one isolate classified as Psp2 is in fact a separate taxon that appears to have evolved from Psp2, i.e., it is the closest relative of Psp2. This isolate, P. sp VHS15032, has been assessed morphometrically and in a pathogenicity trial.

A pathogenicity trial examining the effect of three isolates of Psp2 and P. sp. VHS15032 on *E. marginata* seedlings indicate that Psp2 is as pathogenic as *P. cinnamomi* to *E. marginata*. A pathogenicity trial assessing the virulence of Psp1, Psp2, and Psp9 on *B. attenuata* showed none of these taxa were as virulent as *P. cinnamomi*, but all proved to be pathogenic to *B. attenuata*. Significantly, Psp2 has not previously been associated with this host. Initial investigations into microsatellite analysis of a worldwide population of *P. citricola* have been undertaken. A draft of the species description for Psp2 has been written. Psp2 has been nominally assigned the name *P. lateriticola*, due to its restriction to, and thus association with, the lateritic soils of the jarrah forest.

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**Scientist:** **S van Leeuwen**

*Student:* *G Page*

*Project title*

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

*Project report*

The broad aim of the project was 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, an iron ore mine in the central Pilbara.

Two conference presentations have been given. The first was titled “Response of mulga to simulated cyclonic rainfall varies with phyllode shape in a semi-arid woodland” and was presented at the International Ecohydrology Workshop at UWA in September 2008. The second was titled “Phyllode shape and water use in mulga woodlands: how important is diversity in a changing climate?” and was presented to the Air Pollution and Global Change Symposium: Plant Functioning in a Changing Global Environment, at the School of Forest and Ecosystem Science (University of Melbourne) in Creswick, Victoria in December 2008. All field work has been completed for this project and the candidate is currently working toward completion of his thesis dissertation. Strong. ongoing collaborative links between this project and the Understanding Mulga project (DEC) have been developed with the primary purpose of determining the genetic similarity of the mulga ‘types’ identified within the West Angelas study area.

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**Scientist:** **A Wayne**

*Student:* *K Zosky*

*Project title*

**Food resources and woylie declines in south-west Western Australia**

*Progress report*

The aim of the project is to examine the dietary ecology of the woylie and investigate its role in current population declines. Specific aims are to examine temporal and spatial variation in the diet of the Woylie; examine changes in woylie diet in relation to population decline, and investigate food resource availability.

The study basically involves two components, an assessment of diet using faecal material collected during woylie population monitoring and seasonal fungi surveys to assess food resource availability. The diet assessment was completed in April 2009. Approximately 500 samples have been analysed. The fieldwork for the project (seasonal fungi surveys) was also completed in April 2009. Fifty-four species of hypogeal fungi have been identified for the project. Data analysis on the diet and fungi survey results has commenced. Thesis writing is also in progress. Preliminary results were presented during an oral presentation at the Australian Wildlife Conservancy Student Research Symposium held at Karakamia Sanctuary on 1 May 2009. An abstract for a poster presentation has also been submitted for the Australian Mammal Society Conference to be held in Perth in July 2009.

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**Scientist:** **A Wayne**

*Student:* *C Pacioni*

*Project title*

**A conservation conundrum: the population and epidemiological dynamics associated with recent decline of woylies (*Bettongia penicillata*) in Australia**

*Progress report*

A vital complement to the existing research and conservation endeavours is a sound understanding of the genetics of this species. As an integral component of the diagnosis of woylie declines, this specific project proposes to characterise woylie genetics directly relevant to conservation and recovery of the species, and to relate these findings to the epidemiology and demographics of declining populations. In so doing, this research will inform the priorities for conservation efforts and anticipate the likely consequences for future species recovery and conservation. We also intend to investigate paternity, social structure, home range and individual’s movements between adjacent populations. In addition to improving the knowledge of the ecology of the species, this information is expected to help define the epidemiology of diseases that may be currently threatening declining populations.

Field and lab work has been completed for both genetic and virus investigation. Genetic data have been analysed and the results drafted in four papers which are currently being finalised. The demographic model is under development.

**Scientists:** **A Wayne and N McKenzie**

*Student:* *Paul Webala, Murdoch University*

*Project title*

**Bat community structure and habitat use across disturbance regimes in jarrah forests, south-west Western Australia**

*Progress report*

The project consists of two major components. First, investigating bat community responses to jarrah forest logging in south-west 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.* This has done by means of radio-telemetry, roost site characterisation, vegetation assessments and measures of insect abundance.

A manuscript on bat responses to jarrah forest logging is in preparation for publication. Two out of the nine extant species of bats may be affected by jarrah forest logging in the short term. Current management practices create a mosaic of successional stages within a matrix of a disturbed and undisturbed landscape that may have temporal effects on abundance and species richness of bats but in the long term may satisfy the requirements of many species. Bat activity along tracks was apparently unaffected by logging/forest structure supporting other published data that tracks traversing selectively-logged forests are important in improving the habitat quality for a range of bat species, and should therefore be maintained for the long-term persistence of bats. The radiotracking activity will be completed in summer 09/10 - preliminary findings show that Gould's long-eared bat *N. gouldi* and the Southern forest bat *V. regulus* select roosts only in old regrowth and mature unlogged forests. There are also clear differences in roost-site selection between species but individuals of both species use multiple roosts underscoring the importance of maintaining multiple roosts with a diverse range of characteristics including hollow-bearing trees.

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**Scientist:** **A Wayne**

*Student:* *P Rogers*

*Project title*

**Predator profiling as a tool for the conservation of the woylie**

*Progress report*

This project aims to determine the feasibility of using rabbit carcasses as a model for woylie, and other native medium-sized mammals in captive trials; identify the predator/scavenger species responsible for the characteristics on a consumed prey carcass; identify any differences between predator/scavenger individuals and changes over time, in the characteristics of a prey carcass; and categorise the carcass characteristics caused by two predator/scavenger species, namely feral cat and wedge-tailed eagle.

Results show that distinct carcass characteristics and consumption patterns were identifiable between feral cats and wedge-tail eagles. Individual differences were observed within predator/scavenger species in the characteristics of the prey carcass. Differences were observed over time in the consumption characteristics of a carcass. Differences were observed in the consumption patterns of feral cats between wild rabbit carcasses and farmed rabbit carcasses. Carcass characteristics observed on rabbit carcasses in captive trials mirrored the recorded carcass attributes of woylie carcasses consumed in the wild.

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**Scientist:** **A Wayne**

*Student:* *R McCracken*

*Project title*

**The status of key south-west Australian brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*) populations and the role of animal health and disease in the absence of recovery from population decline**

*Progress report*

This project aims to determine the current status of key brush-tailed phascogale populations; collate

unpublished and published population data with the objective of clarifying changes in phascogale abundance since the 1994 decline; determine the role of health, body condition and disease in the failure of key brush-tailed phascogale populations to recover from decline; and compare phascogale abundance, health, body condition and disease between forest and agricultural populations, and/or to a close relative, the red-tailed phascogale (*Phascogale calura).*

Nest box monitoring for the brush-tailed phascogale has been conducted in the Warren region (11 sites, 425 boxes). Six animals were found during the initial survey in February and 18 during the June survey period. Trapping (978 trap nights) near Kirup at Catterick forest block yielded no phascogales. Three populations (Melden, Dardadine and Wadderin) of red-tailed phascogales were trapped in May and June, with 30 animals captured. Samples of blood, tissue, ectoparasites and faeces have been taken. Bacterial, haemoparasite, ectoparasite and endoparasite analyses are pending.

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**Scientist:** **A Wayne**

*Student:* *K Bain*

*Project title*

**Ecological study of the quokka (*Setonix brachyurus*) in the southern forests of south-west WA**

*Progress report*

This project aims to determine if a reliable estimate of quokka abundance can be obtained from indicators of activity including scats, tracks and runnels; identifty the preferred habitat of quokkas in southern forests in relation to factors such as vegetation structure and floristics, position in the landscape, landform systems and geomorphology; identify the current distribution and abundance of quokkas in the southern forests (Warren Region) and this influence of fire and the presence of feral pigs; determine the mobility and activity patterns of quokkas in the broader landscape and whether the sub-populations constitute a functional meta-population

Trapping webs have been established at 16 sites - scat collections, runnel counts track counts and trapping have been completed at each site. Analysis indicates that faecal pellet counts relate strongly (runnels less so) to population abundance. There is no relationship between population abundance and tracks or incidental sightings. Runnels are great at detecting presence or absence of quokkas in an area but do not provide any reliable indication of recency of habitat use. The rapid survey technique in its current form does not differentiate between fresh and old scat which can result in a significant overestimation of population abundance. There seems to be a high level of temporal variation in habitat occupancy that is not consistent with the current hypothesis that animals move to the ridgelines in winter and occupy the same creek lines each summer. This temporal variation is important to understand before any further work is completed in relation to habitat preference or response to disturbance.

A GPS collar trial was undertaken on three male quokkas in the Shenton Park native animal facility (December 2008), to determine whether the GPS collars (55g) would adversely affect quokka welfare or behaviour. Signs of discomfort were short-term (less than two hours) before the animals settled back into a normal behaviour pattern. Longer-term welfare problems were not apparent. With subsequent welfare approval, eight quokka were collared in February at two sites to examine habitat use and seasonal movement. After two months, collars dropped off three months prematurely and immediately prior to seasonal movement. This particularly important work will need to be completed next autumn.

A draft manuscript has been prepared for the rapid survey validation aspect of the project.

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**Scientist:** **R Wittkuhn**

*Student:* *B Pekin*

*Project title*

**Influence of fire frequency and resource gradients on the structure and diversity of the jarrah (*Eucalyptus marginata* Donn ex Sm.) forest of south-west Australia**

*Project report*

The project assessed impacts of fire frequencies and resource gradients (in terms of soil nutrients and aridity) on (i) the abundance and biomass of dominant tree species, (ii) overall species and life form diversity, and (iii) the diversity of functional plant species assemblages in the jarrah (*Eucalyptus marginata*) forest of south-west Australia.

While both fire regime and water stress may influence the composition of the overstorey, overall stand productivity is likely to be insensitive to increased fire frequency. High fire frequency may increase the relative number of herbaceous species, particularly at more productive sites where competition for light is high. Understorey composition is mediated by resource allocation, nutrient harvesting and growth rate trade-offs among different functional plant assemblages along soil nutrient (N and P) gradients. Overall species diversity measures such as richness and evenness are dependent on the intensity of competition for nutrients versus light, which is mediated by an interaction between fire regime and site productivity. In conclusion, trade-offs among different functional plant assemblages and fire impacts on competition intensity for nutrients and light may have an important role in mediating co-existence and maintaining species diversity in the southern jarrah forest.

The thesis was submitted in May 2009. One manuscript has been submitted for publication, with more to follow.

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**Scientist:** **C Yates**

*Student:* *A Franks*

*Project title*

**Landscape fragmentation and rare plant species: Can we develop a general framework of population responses?**

*Progress report*

The aims of the project are to categorise 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; 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; and 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.

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