DEC – CSIRO

STRATEGIC DIRECTIONS WORKSHOP

WESTERN AUSTRALIAN CONSERVATION SCIENCE CENTRE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KENSINGTON

Monday 28 February 2011
Tuesday 1 March 2011
Wednesday 2 March 2011

Department of Environment and Conservation

CSIRO

DEC – CSIRO WORKSHOP

Western Australian Conservation Science Centre, Kensington

Participant Information

Monday 28 February: 'Breaking the Ice get together'

The Boatshed Restaurant (http://www.boatshedrestaurant.com/)
Coode Street Jetty
Coode Street, South Perth WA 6155
Time: 7:00pm
A set menu has been ordered.

Tuesday 1 March and Wednesday 2 March - WACSC, Hayman Road, Kensington

Tuesday 1 March: 'Catered BBQ and tour of AWC's Karakamia Sanctuary – all invited.

Karakamia Sanctuary
(http://www.australianwildlife.org/AWC-Sanctuaries/Karakamia-Sanctuary.aspx)
Transport has been arranged, departing from WA Conservation Science Centre at 4:15pm, returning to WACSC or drop off around Perth at accommodation at about 9:00pm

No alcohol allowed. Soft drinks and water will be supplied. A BBQ will be followed by a 1.5 hour guided tour of the Karakamia Sanctuary.

If you have any queries about anything on arrival or during the workshop, please do not hesitate to contact Glenda Lindsey or Stephen van Leeuwen. Details are below:

Glenda: Work Phone: (08) 9219 9077
Mobile: 0467 702 533
Email: glenda.lindsey@dec.wa.gov.au

Stephen: Work Phone: (08) 9219 9042
Mobile: 0438 757 556
Email: stephen.vanleeuwen@dec.wa.gov.au

DEC – CSIRO

List of Attendees at
STRATEGIC DIRECTIONS WORKSHOP

Western Australian Conservation Science Centre
Department of Environment and Conservation

Name		Affiliation	Email Contact Details
Dr Alan	Andersen	CSIRO	Alan.Andersen@csiro.au
Dr Oliver	Berry	CSIRO	Oliver.Berry@csiro.au
Dr Margaret	Byrne	DEC	margaret.byrne@dec.wa.gov.au
Dr David	Coates	DEC	dave.coates@dec.wa.gov.au
Dr Raphael	Didham	CSIRO	Raphael.Didham@csiro.au
Dr Owain	Edwards	CSIRO	owain.edwards@csiro.au
Mr Paul	Gioia	DEC	paul.gioia@dec.wa.gov.au
Dr Leo	Joseph	CSIRO	Leo.Joseph@csiro.au
Dr Lachie	McCaw	DEC	lachie.mccaw@dec.wa.gov.au
Mr Keith	Morris	DEC	keith.morris@dec.wa.gov.au
Dr Suzanne	Prober	CSIRO	Suzanne.Prober@csiro.au
Dr John	Scott	CSIRO	John.K.Scott@csiro.au
Dr Andy	Sheppard	CSIRO	Andy.Sheppard@csiro.au
Dr Kevin	Thiele	DEC	kevin.thiele@dec.wa.gov.au
Dr Stephen	van Leeuwen	DEC	stephen.vanleeuwen@dec.wa.gov.au
Dr Colin	Yates	DEC	colin.yates@dec.wa.gov.au
Dr Andrew	Young	CSIRO	Andrew.Young@csiro.au

DEC – CSIRO WORKSHOP

Western Australian Conservation Science Centre (WACSC)

A G E N D A

Monday 28 February:
7.00pm: Dinner at The Boatshed

Tuesday 1 March:
Meet in Torndirrup and Nambung Meeting Rooms at WACSC
8.30am: Welcome - Margaret Byrne and Andy Sheppard
Background to WABRI - Stephen van Leeuwen

9.00am: Existing Collaborations

10.30am: Morning Tea

11.00am: Pathways for capitalizing on existing collaborations

12.30pm: Lunch – in the Canteen (next door to the Meeting Rooms)

1.00pm: New initiatives

3.00pm: Afternoon Tea

3.30pm: Recap on Day 1

4.00pm: Wind up

4.15pm: Leave for Karakamia Tour of the Sanctuary and BBQ dinner.

Wednesday 2 March:
Meet in Torndirrup and Nambung Meeting Rooms at WACSC
8.30am: Pathways for development of new synergies

10.00am: Morning Tea

10.30am: Pathways for development of new synergies continued

12.00pm: Lunch

12.30pm: Future Directions

1.30pm: Wind up

DEC – CSIRO WORKSHOP

Western Australian Conservation Science Centre, Kensington

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3	High throughput assessment of invertebrate biodiversity and metacommunity structure using ecogenomics technology	CSIRO – O Edwards, R Didham, S Ferrier DEC – S van Leeuwin
4	Plant invasions in Mediterranean climate hotspots of Australia and South Africa	DEC – C Yates CSIRO – B Webber, J Scott
5	Terrestrial Ecosystems Research Network (TERN) Great Western Woodlands Supersite	DEC – S van Leeuwen, C Yates, M Byrne, K Thiele, N Gibson, I Kealley CSIRO – S Prober, C MacFarlane, R Silberstein DEC/CSIRO - C Gosper
6	Fire, fragmentation, weeds and the conservation of plant diversity in Wheatbelt Nature Reserves	DEC –C Yates CSIRO – S Prober DEC/CSIRO – C Gosper
7	Fire in the Great Western Woodlands	DEC – C Yates, L MCCaw CSIRO – S Prober DEC/CSIRO – C Gosper
8	Projecting trends in plant community composition and regional biodiversity under climate change	CSIRO – S Ferrier DEC – C Yates, N Gibson
9	Climate-resilient revegetation of multi-use landscapes: exploiting genetic variability in widespread species	DEC – M Byrne CSIRO - S Prober, A Young, C MacFarlane
10	Pathways to weed invasion in the Great Western Woodlands (GWW)	DEC – C Yates CSIRO – S Prober, J Scott DEC/CSIRO – C Gosper
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13	Fire behaviour and fuel dynamics in eucalypt forests and mallee shrublands	CSIRO – J Gould, M Cruz, J Hollis DEC – L McCaw

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14	Fire regimes and biodiversity in Kimberley savanna ecosystems	CSIRO – A Andersen, I Gordon, A Kutt DEC – I Radford, L McCaw
15	Fires in forested landscapes in south west Western Australia	CSIRO – A Andersen DEC – L McCaw, R Wittkuhn
16	Impact of smoke from biomass burning on air quality in rural communities	CSIRO – F Reisen, Mick Meyer, J Powell, M Keywood, J Gras DEC – L McCaw
17	Atlas of Living Australia descriptive data infrastructure	DEC – K Thiele CSIRO – Doherty, D Hobern
18	Molecular taxonomy / systematics of Mulga	DEC – B Maslin, M Byrne, J Reid CSIRO – JMiller
19	Conservation genetics of Western Ground Parrots	DEC - A Burbidge CSIRO - L Joseph AWC – J Austin
20	Modelling communities distribution in the Pilbara	DEC – N McKenzie, A Pinder, A Burbidge, S van Leeuwen CSIRO – S Ferrier
21	Biotech aids for eradicating invasive pests from Christmas and Cocos-Keeling islands	DEC – D Algar CSIRO – O Berry
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23	Invertebrate inventories – Pilbara Biological Survey	DEC – N Guthrie, B Durrant, N McKenzie, S van Leeuwen CSIRO – T Weir, S Shattuck, K Pullen
24	Biodiversity assessment and management	CSIRO – L Joseph, D Yeates, S Cameron DEC – A Burbidge, K Thiele, M Byrne
25	Metagenomics / Ecogenomics	CSIRO – O Edwards, C Hardy DEC – To discuss
26	Change across large scale environmental gradients	CSIRO – L Joseph, D Yeates, S Cameron, A Slipinski, R Oberprieler, O Edwards, C Hardy DEC – M Byrne, S van Leeuwen

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Plant population viability in fragmented landscapes
Phase 1. Genetic and ecological viability of plant populations in remnant vegetation
Phase 2. Molecular ecological analysis of vegetation function in fragmented Australian biomes.
Project Objective: To understand and quantify how genetic and demographic processes interact to influence the viability and long-term conservation value of native plant populations in remnant vegetation, and relate this to easily measured landscape and population parameters. Subsequently in Phase 2 we further developed the use of molecular ecological techniques and population models to formulate an explicit understanding of the importance of gene flow and seed dispersal ***among*** populations for determining local species persistence, and how this is affected by landscape configuration. Phase 2 specifically built on the findings of Phase 1 regarding the effects of habitat fragmentation on the viability of single plant populations by extending the analysis to the development of more realistic multi-population remnant vegetation management models.

Key staff:
DEC – Dr David Coates, Dr Margaret Byrne, Dr Colin Yates
CSIRO – Dr Andrew Young, Dr Linda Broadhurst

Project investment and timeframe:
Phase 1. 3 years - (2002-2005) DEC $327,000 - CSIRO $330,000 - Land and Water Australia $800,000 **- Total $1,457,000**
Phase 2. 2 years – (2006 – 2008) DEC $ - 364,000, CSIRO $202,000, Land and Water Australia $450,000. – **Total $1,016,000**

Current status:
- Final projects reports have been completed for both phases
- 11 refereed journal publications
- 7 publications in preparation
- 12 verbal conference presentations
- 8 conference poster presentations
- 12 articles

In the next 12 months we plan to draft a review paper covering all the findings in Phase 1 from the two contrasting biomes in New South Wales and Western Australia, based on the seven target taxa.

Future directions:
To develop further our understanding of the impacts and mitigation of habitat fragmentation particularly in the context of predicted climate change and the increasing demand for broadscale ecological restoration of fragmented landscapes. With the rapid development of landscape genetic approaches and new molecular genetic technologies there are significant opportunities for the development a new approaches in ecological restoration that better factor in ecological and genetic processes so as to maximise “landscape viability”.

Outcomes and management implications:
- Improved ability for landholders and managers to assess the viability of remnant plant populations based on limited knowledge of remnant characteristics and species life history.
- Clear goals regarding remnant size and landscape configuration that maximise regional persistence of plants species.
- Identification of knowledge gaps in our understanding of relationships between vegetation remnant characteristics, species life history traits and plant population viability.
- Improved ability for land managers to manage groups of vegetation remnants simultaneously, identify realistic goals regarding landscape configuration and the best locations for revegetation activities to maximise genetic connectedness, and develop ecological restoration guidelines.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Feasibility of assisted migration as a climate change adaptation strategy for Australian plants

Key staff:
Dec – Margaret Byrne, David Coates, Colin Yates, Leonie Monks
CSIRO – Andrew Young, Linda Broadhurst

Project investment and timeframe:
Project is a proposal for funding from Biodiversity Hub of NCCARF – invitation to submit full proposal.
NCCARF funding sought - $165 000
DEC – CSIRO - $200 000 (in kind)
Planned time frame – July 2011 to December 2012.

Current status:
Project design developed.
In the extensively fragmented landscapes of temperate southern Australia assisted migration may be the only option for facilitating the persistence of poorly dispersed plant species and increasing the capacity of ecosystems to undergo transformative change in the face of climate change. We need to know the feasibility of assisted migration as a climate change adaptation strategy and evaluate whether current policies hinder or enable assisted migration. This project will collate disparate but valuable data on plant species translocations in Australia and undertake a meta-analysis to determine the factors affecting success. These results will be integrated with species distribution modelling under the influence of climate change to determine the feasibility and cost of assisted migration. In addition the operational and policy considerations of assisted migration will be considered in two workshops.

Future directions:

The project has national significance as it addresses a fundamental gap in knowledge relating to the use of assisted migration as a climate adaptation strategy. Analysis of existing translocation data represents a cost-effective means of evaluating the feasibility of assisted migration and delivering improved policy outcomes that facilitate species persistence and ecosystem resilience under changing climatic conditions. This is a seed project for further work in this area.

Outcomes and management implications:

The project will produce a database of plant species translocations in Australia and rigorous analysis of the factors influencing the success of plant translocations. This will enable the feasibility of assisted migration as a climate change adaptation strategy to be assessed.
Recommendations for revised translocation policies and guidelines that take into account projected climate change scenarios will have implications for policy setting in Australia at Federal and State level.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
High throughput assessment of invertebrate biodiversity and metacommunity structure using ecogenomics technology.

Key staff:
CES - Owain Edwards, Raphael Didham, Simon Ferrier
DEC - Stephen van Leeuwin

Project investment and timeframe:
$950K

Current status:
Contract soon to be finalised with SIEF. Kimberley sampling plan being developed for 2011-2012.

Future directions:
This project will apply ecogenomics methods to rapidly assess invertebrate biodiversity from pooled invertebrate samples collected from distributed Malaise traps (or other standardised mass sampling techniques). The data collected will be used to build and begin populating a distributional database of invertebrate "taxonomic units" in the Eastern Kimberley region of Western Australia, while also assessing the value of the ecogenomics approach over traditional methods to understand the determinants of terrestrial invertebrate metacommunity structure. The first key advantage of the ecogenomics approach is the capacity to examine relationships between diversity and environmental variables across all members of the invertebrate community simultaneously, providing stronger support for predictions of the functional bases for these relationships. The second key advantage of the ecogenomics approach is derived from the evolutionary information inherent in DNA sequence data, providing this project with a framework to generate a community structure weighted by the relatedness of the sampled taxa. This feature of ecogenomics data will be incorporated into the novel biodiversity metrics developed as part of this project. The third key advantage of the ecogenomics approach is the capacity to generate within-species diversity information as part of the same analysis. This within-species data will be used to examine speciation processes, which will be incorporated into the description of metacommunity structure, providing some resolution to an ongoing debate about what assumptions about speciation processes are valid in current models. The spatial scaling of speciation processes will also be examined, comparing biogeographic patterns of population genetic divergence to patterns of species diversity. Theory predicts that there should be positive covariance between these two measures of diversity, but this has only been examined for individual species. In this study, ecogenomics will be used to test whether this theory hold more broadly across an entire metacommunity.

Outcomes and management implications:
This is a pilot project which, if successful, is likely to attract additional investment from SIEF for expanded work. Information in the invertebrate biodiversity distribution database can be used immediately for management decisions, in particular to inform decisions of boundaries of reserve areas or conservation management units. Once the approach is validated, industry will be approached to support this ecogenomics technology as a means to rapidly assess whole of ecosystem impacts of resource projects.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Plant invasions in Mediterranean climate hotspots of Australia and South Africa

Key staff:
Colin Yates (DEC), Bruce Webber (CSIRO), John K. Scott (CSIRO), David Le Maitre (CSIR, South Africa), Guy Midgley (SANBI, South Africa), Dave Richardson (CIB, Stellenbosch)

Project investment and timeframe:
Proposed – three years July 2011 – June 2014 at $100K per year plus in kind

Current status:
Two of the world's ecological "hotspots", south west Australia and the Cape region of South Africa, have similar climates and a native flora with Gondwanan origins and phylogenetic similarities. Both regions share and have exchanged invasive plant species that are significant problems for regional conservation objectives, thus contributing to the threatened aspect of the "hotspot" classification. These invasions may provide lessons of what to expect of invasion processes under future climate change, for both native and introduced plant distributions.

To investigate this idea, a collaboration between Australia and South Africa has been established following a workshop held December 2009 at Kirstenbosch National Botanic Gardens in Cape Town, South Africa. (called the second phase, following earlier work between DEC and SANBI South Africa)

We have now completed analyses on four acacia species (*Acacia cyclops*, *A. pycnantha*, *A. paradoxa*, *A. saligna*), *Anigozanthos flavidus* and *Watsonia bulbilifera*. Three papers have been submitted, and two more are in preparation from the second phase, to be completed June 2011.

Future directions:
The next phase (phase 3) will
1. Investigate the ecophysiology of *Anigozanthos flavidus* and *Watsonia bulbilifera* in more detail, including field and experimental tests of models developed during phase 2.
2. Further investigate acacia species to test fundamental issues in modelling invasions.
3. Expand the range of species to include other invasive plants of Australian and South African origin so as to illustrate different aspects of species invasions and climate change.
4. To develop regionally appropriate climate change studies for south west Australian and south west Africa.

Outcomes and management implications:
1. Scientist and management experience on invasive plants in South Africa transferred to south west Australia and vice versa.
2. Improved management of key weed species in both countries.
3. Development of species distribution modelling systems appropriate for south west Australia and South Africa.
4. Information to enable risk assessments of climate change.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Terrestrial Ecosystems Research Network (TERN) Great Western Woodlands Supersite

Key staff:
DEC: Steve van Leeuwen, Colin Yates, Margaret Byrne, Kevin Thiele, Neil Gibson, Ian Keally
CSIRO: Suzanne Prober, Craig MacFarlane, Richard Silberstein
CSIRO/DEC: Carl Gosper

Project investment and timeframe:
$1.2M, January 2011 to June 2014

Current status:
Funding approved through TERN

Future directions:
The supersite will aim to work towards building a process-based ecosystem model to inform ecosystem response to management and climate change. TERN is intended to support long-term ecological study, however funding beyond 2014 is dependent on state and other co-investment. PhD, honours students, post-docs and collaborations through a consortium of scientists from WA universities etc. will be sought to augment core Supersite activities. Links also to DEC SWATT transect.

Outcomes and management implications:
The Great Western Woodlands (GWW) comprise a 16 million hectare mosaic of temperate woodland, shrubland and mallee vegetation in south-west WA. The region is extraordinary in that it has remained relatively intact since European settlement, owing to the variable rainfall and lack of readily accessible groundwater. The woodland component is globally unique in that nowhere else do woodlands occur at as little as 250 mm mean annual rainfall. Further, other temperate woodlands around the world have typically become highly fragmented and degraded through agricultural use. The GWW thus provide a unique model for studying how naturally functioning, relatively intact ecosystems can adapt to climate change, and for understanding how temperate woodland ecosystems function at site and landscape scales. The adjacent Western Australian wheatbelt has many areas of analagous climate, geology and vegetation to the GWW, but is extensively fragmented and degraded. The GWW offer significant potential to inform climate-resilient restoration of the WA wheatbelt.
The key questions to be answered at the GWW supersite relate to the impacts of climate change and management on biodiversity and on the fundamental flows of energy, carbon, water and nutrient stocks in semi-arid woodlands. Some of the questions directly relevant to management include:
•What are optimal fire regimes for WA semi-arid woodlands?
•What areas and communities should be the focus of fire protection in a changing climate?
•How can new invasions be prevented and major invaders such as Buffel grass be contained?
•How can local Aboriginal knowledge inform natural resource management?
•What genotypes/functional types are best utilized for climate-resilient wheatbelt revegetation?
•What options are there to facilitate climate adaptation in intact, heterogeneous landscapes?

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Fire, fragmentation, weeds and the conservation of plant diversity in Wheatbelt Nature Reserves

Key staff:
Suzanne Prober (CSIRO), Colin Yates (DEC), Carl Gosper (CSIRO/DEC)

Project investment and timeframe:
CSIRO $180K; DEC $180K, February 2007-June 2010

Current status:
Finalising publications and management implications arising from the project.

Future directions:
Project is winding down, with current efforts of the project team being directed to the joint DEC-CSIRO collaboration 'Fire in the Great Western Woodlands' (details on another project statement).

Outcomes and management implications:
The project has contributed significant new information that will lead to improved fire management of wheatbelt remnants.

- *Aim 1: What are the current fire regimes experienced by remnants of native vegetation in the region, and how do these relate to landscape context, such as remnant size and configuration?* Outcomes: A comparative analysis of historical fire regimes between the fragmented landscape of the wheatbelt and contiguously vegetated areas in the Great Western Woodlands was completed, with fires found to be most frequent in contiguous vegetation and least frequent in small remnants.
- *Aim 2: What are the upper and lower limits of the fire interval needed to maintain diversity in plant communities in remnants?* Outcomes: A network of sample sites was established across a time since fire gradient in two common plant community types: tallerack mallee-heath and mallee shrubland. The two communities showed different patterns of vegetation composition and structural change with increasing time since fire, with mallee-heath showing declining species richness and senescence in structure when long-unburnt, whilst mallee does not. A management implication from this work is that many small mallee-heath remnants in the wheatbelt are likely to be senescing, and that active fire management may be necessary for their long-term conservation.
- Plant vital attributes (mortality and fecundity) for selected species of functional types likely to be susceptible to fire interval-related decline were sampled across the time since fire gradient. Many serotinous species took 20-30 years post-fire to accumulate a substantial seed bank in both communities, but some obligate seeding species had high mortality in long-unburnt (> 50 years) mallee-heath. This work allows for the identification of acceptable fire-return interval bounds for the eastern wheatbelt.
- *Aim 3: How do current fire management methods, such as chaining and burning, affect native plant communities?* Outcomes: Chaining and burning reduced recruitment in serotinous obligate seeders and reduced the resprouting capacity of mallees. These impacts need to be balanced against the fire management benefits of chaining and burning.
- *Aim 4: Do fire and other disturbances interact to reduce resistance of eastern wheatbelt plant communities to weed invasion?* Outcomes: In an experiment investigating the effects of fire, weed seed addition and landscape context (reserve edges vs. Interiors) on weed abundance and biomass, weed invasion was greater at nutrient enriched edges of reserves, irrespective of whether these were burnt or not. Invasion in reserve interiors was minimal. In these low-nutrient ecosystems, fire is a viable disturbance option for biodiversity conservation away from nutrient-enriched edges.

Outputs: Technical: 3 papers published, 1 in press, 2 in review and 2 in preparation, and 5 presentations at scientific conferences. Extension: 1 popular article, 4 Information Sheets and presentations at 3 workshops for land managers.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Fire in the Great Western Woodlands

Key staff:
Colin Yates, Lachie McCaw (DEC)
Suzanne Prober (CSIRO)
Carl Gosper (DEC/CSIRO)

Project investment and timeframe:
$140K 2011-2013

Current status:
Funded.

Future directions:
The project has commenced and is using space-for-time surveys and already developed fire history databases, to investigate the effects of time since fire and fire interval on assembly and recovery of plant community composition, development of ecosystem structure, and fuel dynamics in eucalypt woodland ecosystems.

The project is a component of the TERN Great Western Woodlands Supersite.

Outcomes and management implications:
The GWW is an internationally significant area of great biological and cultural significance. It supports eucalypt woodlands at very low mean annual rainfall (250-350 mm), that require fire to establish but are very slow growing. In recent decades a large part of the GWW has been burnt and concern has been expressed over the ecological impacts of this. Sparse knowledge on the fire ecology of GWW ecosystems is a major impediment for determining what ecologically appropriate fire regimes should be. Fire ecology research undertaken in Eastern Wheatbelt Nature Reserves by the joint DEC (BCI)-CSIRO project has helped resolve this for mallee and mallee-heath communities in the GWW, but similar information for the dominant eucalypt woodlands is urgently needed.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Projecting trends in plant community composition and regional biodiversity under climate change

Key staff:
Mirrka Jones, Jens-Christian Svenning (Aarhus University), Simon Ferrier (CSIRO – Climate Change Adaptation Flagship) Colin Yates, Neil Gibson (DEC)

Project investment and timeframe:
June 2011-June 2013.

Mirrka Jones – post doctoral research funded through a consortium of Finnish Foundations and involving Ecoinformatics and Biodiversity Research Group, Aarhus University, Denmark; CSIRO Climate Change Adaptation Flagship; and DEC.

Current status:
Beginning June 2011.

Future directions:

1) Using high quality floristic and environmental datasets from two case study regions with starkly contrasting climatic and geological histories, South-west Australia and Europe, the project will apply novel statistical methods to model present and future trends in plant species richness and composition under altered climate scenarios.

2) Within sub-regions, the project will investigate the link between present-day patterns, these future predictions, and the amount of environmental heterogeneity in the landscape. In this context, the distribution of fine-scale, topographically defined microhabitats that are cooler or more humid than average, and represent possible micro-refugia of the future, will be of particular interest.

Outcomes and management implications:

High-quality present-day models of plant community turnover and species richness.

A suite of increasingly complex and realistic models of likely changes in current species assemblages under different climate change scenarios (different emissions scenarios, different amounts of time into the future).

Estimates of the likely degree of retention of present-day biodiversity under those future climate scenarios.

Improved ability to identify cool and humid microhabitats from digital environmental map layers.

Improved understanding of the relevance of cool/humid microhabitats (potential micro-refugia) and other aspects of landscape structure within species' current ranges for biodiversity retention.

Improved understanding of the relevance of dispersal limitation (dispersal capacity, dispersal barriers) and landscape structure for future biodiversity patterns and biodiversity retention across spatial scales.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Climate-resilient revegetation of multi-use landscapes: exploiting genetic variability in widespread species

Key staff:
DEC: Margaret Byrne
CSIRO: Suzanne Prober, Andrew Young, Craig MacFarlane
Edith Cowan University: Will Stock
University of Tasmania: Brad Potts, Rene Vaillancourt

Project investment and timeframe:
1 to 3 years +

Current status:
Project scope has been developed, and genomic and physiology methodology has been identified. The project will utilise recent advances in eucalypt genomics to study key widespread eucalypt species that span climatic gradients across the eucalypt communities of the WA wheatbelt Great Western Woodlands and the box woodlands of the eastern Australian wheatbelt.

Current funding proposals to NCCARF and other sources.
One honours project currently beginning.

Future directions:
This project addresses the use of adaptive variation in plant species to facilitate ecosystem resilience and climate change adaptation responses in multi-use landscapes. There is broad scope to extend studies to a wide variety of species and genetic approaches, in order to establish generalizations regarding the nature of adaptive genetic variation in widespread plant species and its relevance to climate adaptation.

Outcomes and management implications:
Multi-million dollar investments in restoration of Australia's degraded and fragmented multi-use landscapes currently take little account of climate change. Until recently there has been a strong focus on maintaining local genetic patterns for optimal restoration. In a changing climate this paradigm will no longer be relevant. The project will utilise recent advances in eucalypt genomics to describe adaptive variation in key widespread eucalypt species that span broad climatic gradients. Addressing this question will increase climate-resilience of investments in revegetation and commercial plantings.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Pathways to weed invasion in the Great Western Woodlands (GWW)

Key staff:
DEC: Colin Yates
CSIRO: Suzanne Prober, John Scott
DEC/CSIRO: Carl Gosper

Project investment and timeframe:
$156K for Research Scientist Salary and operating.
2012-2013.

Current status:
Not yet fully funded.
DEC funding $50K through the GWW Strategy.
Additional funding required.

Future directions:
As well as the outcomes below, the project will put in place a framework for longer-term monitoring of invasions through the GWW Supersite.

Outcomes and management implications:
A scientific analysis of pathways for weed invasion in the GWW will have many benefits for the region's significant biodiversity values and for sustainable development of natural resources. These will include a:
(1) Shared understanding by industry and community stakeholders of weed risk in GWW.
(2) Better conservation planning and resource management in the GWW integrating weed risk considerations.
(3) Reduced loss of biodiversity values associated with ongoing development in GWW.
(4) Future multi-million dollar expenditure on weed control saved through preventative approach.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Invasive *Passiflora foetida* in the Kimberley: understanding the threat & exploring solutions

Key staff:
Bruce Webber (CSIRO), John Scott (CSIRO), Stephen van Leeuwen (DEC)

Project investment and timeframe:
Proposed project - $160K (DEC managed mining offset (Mt Gibson Mining) and Kimberley/Pilbara Regions) over two years plus in kind from CSIRO and logistics input from DEC and Mt Gibson Mines in the Kimberley (still being negotiated)

Current status:
Passiflora foetida (stinking passion flower) is an important exotic invasive weed of rainforest patches in the Kimberley andalong riparian systems in the Pilbara. It appears to be spreading into drier habitats and adjacent southerly regions, possibly in response to changing climates. This two year project will (i) measure biological parameters that determine the distribution and abundance of the plant to help improve current control methods, (ii) assess prospects for biological control, and (iii) assess the level of threat posed to the Kimberley and Pilbara by this weed under future climates. The work will include fieldwork focusing on plant populations on Koolan Island, around Kununurra,possibly in the West Kimberley and at Millstream Chichester national park in the Pilbara. The work will also include localised surveys over the wider distribution of the species. This field research will be complemented by glasshouse studies at CSIRO Floreat addressing specific ecophysiological questions.

A recent application to RIRDC for additional funds, which would have enabled a three year project proposal, made it to the final round of assessment but was ultimately not successful.

Future directions:
This project area is under negotiation between CSIRO and DEC. Future directions include expanding the work over a longer timeframe to enable detailed ecological studies to be made of the weed impact on local ecosystems, especially for the reproductive ecology of freshwater crocodiles, and the role of *P. foetida* in resilience of rainforest patch biodiversity and structure to fire and pest animals.

Outcomes and management implications:
(i) an assessment of the spread potential for *P. foetida* and an improved understanding of its ecology
(ii) an assessment of the reproductive ecology of *P. foetida* so as to better inform control strategies
(iii) a preliminary contribution towards developing biological control for *P. foetida*.
(iv) a preliminary assessment of climate change risks posed by invasive species in the Kimberley

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Identification of blackberry decline and the assessment of its potential for biological control

Key staff:
John Scott (CSIRO), Paul Yeoh (CSIRO), John Asher (DEC Bunbury), Brad Barton (DEC Manjimup), Giles Hardy (Murdoch Uni), Treena Burgess (Murdoch Uni), Greg Keighery (DEC)

Project investment and timeframe:
1. $20K per year from DEC to support Murdoch funded PhD student, Sonia Alhighi.
2. A possible $50K (to June 2012) funding from RIRDC to CSIRO to support sampling.

Current status:
Since 2005, dead and diseased blackberry plants (*Rubus anglocandicans*) have been found at three locations along the Warren and Donnelly Rivers. The extent of the disease, with noticeable landscape changes due to removal of dense blackberry infestations, has lead to it being called "blackberry decline". The project aims to investigate the organism(s) causing blackberry decline and to ascertain what risks might be involved and the potential for using these organism(s) for biological control of this weed. A PhD student (Sonia Alhighi) has started on the project (supervisors Giles Hardy, Treena Burgess, John Scott). She has identified some likely organisms that could cause the decline. The identification and testing of these organisms will take up the major part of the thesis.

We have a management group that meets twice a year to oversee the work (John Asher (DEC), Chris Dunne (DEC), Brad Barton (DEC), Ashley Millar (A/Program Coordinator, Invasive Plants), Giles Hardy (Murdoch Uni), Treena Burgess (Murdoch Uni), John Scott (CSIRO), Paul Yeoh (CSIRO).

Future directions:
CSIRO (John Scott) has obtained project approval in the RIRDC weeds round just announced to carry out surveys and sampling for complexes of organisms associated with blackberry decline as part of a larger national project on declines observed in weeds of national significance (PI Rieks van Klinken). The amount of funds is being negotiated (probably $50K). The information and samples from this work will support the PhD work at Murdoch and will provide samples for a 454 pyrosequencing to detect organisms associated with decline. The details of this analysis are being worked out at present. The sequencing analysis work will be based in Canberra (with Andrew Bissett).

Outcomes and management implications:

1. A potential biological control agent maybe found as a results of the surveys and plant pathology.
2. Surveys of the current extent of decline in the Warren and Donnelly catchments.
3. Understanding the disease will aid restoration and management of the decline situation.
4. Test of DNA sequencing approach versus classical plant pathology.
5. National comparison with other decline phenomenon.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Fire behaviour and fuel dynamics in eucalypt forests and mallee shrublands

Key staff:
CSIRO Ecosystem Sciences, Gungahlin ACT - Jim Gould, Miguel Cruz, Jennifer Hollis
DEC - Lachie McCaw

Project investment and timeframe:
DEC (and formerly CALM) have maintained strong links in bushfire behaviour research for over 30 years. Current collaborations include:
Project Vesta – fuel structure, fuel dynamics and fire behaviour in dry eucalypt forests (since 1997)
Project FuSE - fire dynamics in mallee heath (since 2006)
Woody Fuel Consumption Project – (PhD student Jennifer Hollis with support from the Bushfire CRC 2007-2011)
Aerial Suppression – assessment of the effectiveness of aerial suppression (2006-2007)
Grassland Curing – assessment of techniques for predicting grassland curing (2006-2007)

Current status:
Project Vesta - experiments and data analysis are complete and a comprehensive final report and field guide for fuel assessment and fire behaviour prediction were published in 2007. Journal publication is well advance with papers published on the deadman zone, comparison of current fire behaviour models, and fuel moisture modelling. Further papers on flame dimensions and temperatures (accepted), fuel characteristics (submitted), fire behaviour experiments (in preparation) and fire behaviour modelling (in preparation)
Project FuSE - data from experiments in mallee communities in WA and SA have been combined for joint analysis of factors determining fire spread. A manuscript is in preparation.
Woody Fuel Consumption Project – 3 sets of experiments have been conducted in WA forests and an extensive dataset from a previous study (Project Aquarius) has been collated and used to evaluate existing models and to develop a prediction model for woody fuel consumption. Additional data from bushfire case studies has been compiled. Publication of findings in scientific journals is progressing with papers on model evaluation (published), effect of fireline intensity on consumption (in press) and model development (in review).
Aerial Suppression – monitoring of aerial suppression effectiveness by research and operations staff is complete. Reporting has been completed and a journal publication is in review.
Grassland Curing – monitoring of grassland curing at field sites throughout WA is compete. 2 peer-reviewed publications are currently in (1) in press and (2) in preparation.

Future directions:
Project Vesta – finalise publication and examine options for automated calculation and fire spread modelling in real time.
Project FuSE – finalise publication and continue with research adoption.
Woody Fuel Consumption Project – submit PhD in March 2011, finalise journal publication, and start validation of woody fuel consumption model. Develop proposal to broaden the characterisation of woody fuels in eucalypt forests as part of a national approach to fuel classification.
Aerial Suppression – finalise publication and research adoption.
Grassland Curing – finalise publication and research adoption.

Outcomes and management implications:
These projects contribute to improved ability to predict the behaviour and environmental effects of bushfires in Australian ecosystems, and provide an objective body of science to address important policy issues relating to the planned use of fire, and quantifying greenhouse gas emissions from bushfires and prescribed burning.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Fire regimes and biodiversity in Kimberley savanna ecosystems

Key staff:
CSIRO Ecosystem Sciences, Darwin, Townsville
1) Alan Andersen (SNCP, KSCS), 2) Iain Gordon & Alex Kutt (ARC Grant)
DEC - Ian Radford, Lachie McCaw

Project investment and timeframe:
1) Relationships between fire regimes, mammals and biodiversity are being studied in the north and east Kimberley (Mitchell Plateau, Carlton Hill). Projects were funded through SNCP, the East Kimberley Fire Project (NRM) and the Kimberley Science and Conservation Strategy (KSCS).
Collaboration research has addressed trophic ecosystem interactions with mammals, particularly invertebrates, with the aim of identifying mechanisms driving mammal populations. Collaboration began in 2006 and is ongoing.
Collaboration has involved insect sorting, identification, field and lab assistance and data analysis. Alan Andersen is co-author on scientific papers examining ant and grass layer invertebrate fire responses. A co-authored report looks at ant associations with *Callitris*.

2) Cat and mammal responses to fire and possible links to mammal decline in northern Australia. Project started in 2010 and will finish in 2013. Coupled with DEC North Kimberley mammal monitoring program to address cat habitat use and impact in savannas with respect to fire.

Current status:
1) CSIRO/DEC fire monitoring studies are ongoing in the North Kimberley. Publications include papers on responses of biota to fire, biogeography and management guidelines.

2) Project in establishment phase in 2010. Field work commences in 2011.

Future directions:
1) Ongoing North Kimberley biodiversity monitoring through the Kimberley Science and Conservation Strategy is secured and informal collaborative work will continue on ant associations. CSIRO and DEC will also continue to collaborate with the University of Tasmania on *Callitris* studies in northern Australia.

2) Completion in 2013.

Outcomes and management implications:
1) Results of collaboration indicate that biota is relatively resilient to small fires, but that there are scale-dependent trophic ecosystem responses to fires >10 km^2. Responses to large fires are evident for mammals, reptiles, grass layer and large ground layer invertebrates. Very extensive fires are unlikely to be beneficial to these groups. There is little evidence that resource limitations are a mechanism underlying fire responses for mammals, but some evidence for increased predation pressure in large burnt areas, which suggests enhance predation as a mechanism underlying fire impacts. Biotic fire responses are short-lived, with recovery of trophic interactions after one wet season if fire scars are patchy and less than about 1 km^2 ha.
Management implications are that fires >10 km^2 should be minimised in savanna landscapes. Fire management should aim to achieve frequent unburnt patches within burn scars of >1 ha to provide refuges from predators. This should be achieved through repeated application of low intensity fire during humid periods in target conservation areas.

2) Test of cat predation-fire hypothesis for northern mammal declines.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Fires in forested landscapes in south west Western Australia

Key staff:
CSIRO Ecosystem Sciences, Darwin - Alan Andersen
DEC - Lachie McCaw, Roy Wittkuhn

Project investment and timeframe:
This project formed a major part of DEC's contribution to the Bushfire Cooperative Research Centre in the period 2003-2010. Roy Wittkuhn was funded as a Post Doctoral Research Scientist by the Bushfire CRC.

Collaboration between CSIRO and DEC involved sorting and identification of ants collected at 30 sites in open eucalypt forest subject to different fire regimes over the past 3 decades. Alan Andresen contributed to analysis of data and as a co-author on the main scientific paper examining responses to different fire interval sequences.

Current status:
Project completed at the end of 2010. Publications include papers on fire history mapping, fire interval analysis, responses of biota to fire, and management guidelines.

Future directions:
Funding for the project ended in 2010 and Roy Wittkuhn has moved on to employment in the environmental consulting sector. Field study sites have been retained as the basis for future monitoring of ecological response to fire regimes in the Walpole Wilderness Area.

Outcomes and management implications:
Results demonstrate the resilience of the biota in open forests and shrublands of south west Western Australia to contrasting fire interval sequences over the past 30 years. Occasional short (3–5 years) intervals between fires are unlikely to have a persistent effect on community composition, though maintaining a regime of short or long intervals may alter species composition and/or abundance. Variability in fire regimes is important for long-term conservation of the biota. For the Warren Region, prescribed burning at an intermediate level of disturbance and incorporating variability in interval length is recommended to achieve the dual objectives of wildfire mitigation and biodiversity conservation.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Impact of smoke from biomass burning on air quality in rural communities.

Key staff:
CSIRO Marine and Atmospheric Research, VIC
Fabienne Reisen, C.P. (Mick) Meyer, Jennifer C. Powell, Melita D. Keywood, John L. Gras
DEC WA
Lachie McCaw
Forest and Ecosystem Science, University of Melbourne, Creswick, VIC
Kevin Tolhurst

Project investment and timeframe:
This project was undertaken with support from the Australian Government Department of Environment and Heritage Clean Air Research Program. Observations were collected throughout 2007 and 2008. The project is now being finalised through publication of results in scientific journals.

Current status:
Ambient measurements of $PM_{2.5}$, ozone and BTEX (benzene, toluene, ethylbenzene and xylene) were made in two rural locations in southern Australia (Ovens Valley, Victoria and Manjimup WA) between 2006 and 2008. In order to distinguish $PM_{2.5}$ associated with smoke from other sources of particulate pollution, particle samples were analysed for specific smoke tracers, levoglucosan, non sea salt potassium ($nssK^+$) and oxalate. The monitoring program clearly showed that, on occasions, air quality in rural areas is significantly affected by smoke from biomass combustion sources with $PM_{2.5}$ showing the greatest impact. Significant increases of $PM_{2.5}$ concentrations above background occurred at both sites during periods of wildfire and prescribed fire leading to exceedences of the 24 hour $PM_{2.5}$ Air National Environment Protection Measures (NEPM) Advisory standard on several occasions. The 1-hour and 4-hour ozone NEPM standards were exceeded only during protracted forest wildfires. Concentrations of the BTEX species were low and never approached the annual NEPM Air Toxics standard at any site.

Future directions:
A detailed project report was submitted to the Department of Environment and Heritage in mid 2008. A manuscript describing the findings of the study is currently undergoing review within CSIRO and will be submitted to journal in the first quarter of 2011.

Outcomes and management implications:
This study provides important baseline information about air quality in areas of rural Australia that experience smoke from prescribed burning and bushfires. Results clearly demonstrate that unplanned bushfires pose a greater risk of exceeding air quality standards than do well executed prescribed fires, and may adversely affect air quality for extended periods of time during the summer months. This information is important for planning the use of prescribed fire to meet biodiversity and community protection objectives. Results from this study are also relevant to consideration of impacts of smoke on viticulture, use of domestic wood heaters in rural communities, and proposed biomass powered energy generation in rural areas.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Atlas of Living Australia Descriptive Data infrastructure

Key staff:
DEC – Thiele
CSIRO – Doherty, Hobern

Project investment and timeframe:
18 months (end June 2012)

Current status:
Project has commenced, with development of the core infrastructure for a global *IdentifyLife* website that can be used by collaborative teams to build ontologies and coded descriptive information for any group of the world's organisms

Future directions:
Completion of a collaborative ontology creation framework, using which teams of experts will create standardised descriptive character lists for groups of organisms.
Completion of the *Key to All Life* key player, which is at least theoretically capable of handling an identification key to all the world's organisms.
Completion of a *My IdentifyLife* collaboration space for registered users of *IdentifyLife.*
Completion and population of IdentifyLife's Keys Index – a global inventory of web-based identification resources.

Outcomes and management implications:
Identification of organisms remains a core activity in biology. The *IdentifyLife* project seeks to move from islands of disconnected descriptive data to a sea of connected descriptive data, with improved accessibility and effectiveness, and the ability to ask novel research questions.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Molecular taxonomy/ systematics of Mulga

Key staff:
DEC – Bruce Maslin, Margaret Byrne, Jordan Reid
CSIRO – Miller

Project investment and timeframe:
12-18 months

Current status:
A manuscript revising mulga based on morphological grounds has been prepared and submitted for publication. A public-access Mulga Manual and electronic key to mulga still need to be completed.

On the molecular side, Miller has analysed chloroplast markers for mulga accessions; this work needs to be completed to manuscript stage, in collaboration with Maslin and Reid and submitted. Microsatellite analyses have commenced but appear to have stalled – further discussions are needed to determine the next steps

Future directions:
Complete manuscript for chloroplast analyses.
Discuss options for completing microsatellite analyses.

Outcomes and management implications:
Mulga is one of the most important, and taxonomically challenging, species in arid and semi-arid Australia. An effective taxonomic treatment for mulga is necessary for lnd management, mine-site rehabilitation and conservation work. Current treatments are inadequate to deal with the complexity of mulga; hence this work will be a milestone in understanding mulga.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Conservation genetics of Western Ground Parrots

Key staff: Allan Burbidge – DEC; Leo Joseph – CSIRO. Stephen Murphy – AWC; Jeremy Austin – University of Adelaide

Project investment and timeframe:
Project was funded jointly by WA DEC, Australian National Wildlife Collection Foundation, the University of Adelaide, and the Australian Wildlife Conservancy. DEC's and ANWC Foundation's contributions are below. Full proposal is attached.
Total DEC = $17,986.80
Total ANWC = $10,996.38
TOTAL DIRECT COSTS $28,983.18

Current status:
Aims were:
1. To measure genetic diversity within and among Ground Parrot populations and assess its relevance to systematics within the species.
2. To test whether there is significant genetic population structure among Western Ground Parrot populations.

The work was published online in November 2010.
It is currently (7 March 2011) available Online at Conservation Genetics as Murphy, S., Joseph, L., Burbidge, A. and Austin, J. A cryptic and critically endangered species revealed by mitochondrial DNA analyses – the Western Ground Parrot. *Conservation Genetics*, Published On line 10 November 2010doi 10.1007/s10592-010-0161-1

Future directions:
Management effort is now being directed at captive breeding and possible translocation so genetic work on the individuals brought into captivity and a genetic basis to captive breeding are needed.

Outcomes and management implications:
Clarifying that species status is warranted for the Western Ground Parrot under any species concept certainly clarifies its evolutionary uniqueness and heightens the urgency of further management plans and actions.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Modelling communities distributions in the Pilbara

Key staff:
DEC: Norm McKenzie, Adrian Pinder, Allan Burbidge, Stephen van Leeuwen
CSIRO: Simon Ferrier

Project investment and timeframe:
DEC will contribute $40,000 to this collaborative venture in addition to a site by species matrix which includes both terrestrial and freshwater aquatic biota. An investment of ~$9M has been made by DEC to generate this matrix.

This collaboration should be completed by early 2012.

Current status:
Formal collaboration between DEC and CSIRO will commence in April 2011. Preliminary discussions have been ongoing since 2007. A scoping workshop attended by Simon Ferrier and Dan Faith (Australian Museum) was held in early 2007.

Future directions:
Ongoing collaboration between agencies is anticipated as new bioregional scale biodiversity surveys are undertaken (e.g. Kimberley, Great Victoria Desert).

Landscape scale modelling, both of species and in the case of DEC's Biogeography Survey program, of biotic communities is a dynamic and rapidly evolving area of scientific endeavour. This is especially so for the disciplines of reserve design, conservation planning, biodiversity gap analysis and in respect to modelling biodiversity attributes such as surrogacy, complementarily and cross-taxon congruence. DEC Science struggles to stay abreast of new methodologies and approaches particularly for community level modelling mainly because of the campaign nature of bioregional scale surveys and subsequent analyses/write-ups and the significant time interval between such analytical/write-up activities. As for the Pilbara Survey and with previous bioregional scale surveys (e.g. SAP – Wheatbelt Survey) the modelling of survey data was directed by external collaborators.

Outcomes and management implications:
The aim of the Pilbara Survey collaboration is to use sophisticated and novel modelling techniques to interrogate the distribution of communities across the Pilbara landscape and to subsequently asses the CAR of the existing conservation reserve system. As a basic output we will be undertaking a gap analysis of the Pilbara conservation estate.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Biotech aids for eradicating invasive pests from Christmas and Cocos-Keeling islands.

Key staff:
DEC: David Algar
CSIRO: Oliver Berry (CMAR)

Project investment and timeframe:
Timeframe: Four year project (one year plus three year extension). Begins May 2011.

Investment: Federal Attorney Generals Department; Christmas Island Phosphate Corp., Christmas Island Shire Council; DEC; CSIRO.

Current status:
Funding: Initial funding approvals given by Christmas Island Shore Council and CI Phosphate. Larger Application for funds is before the Federal Attorney General's Department (notice expected March-April, 2011).

Practical: Field program designed; baseline samples collected; DNA methodologies established; sampling begins in May 2011.

Future directions:
1) Extending this program to invasive species on additional Western Australian islands and beyond (for example, Barrow Island).

2) Conduct detailed effort-cost-benefit modelling for future eradication programs.

Outcomes and management implications:
Cats.
Major outcomes: enable the efficient eradication of cats from Christmas and Cocos Islands.

Procedures:
1) Establish the abundance of cats on Christmas and Cocos Islands prior to eradication.
2) Monitor reduction in abundance of cats in response to eradication program.
3) Determine whether and when eradication of cats has been successful.

Rats.
Major outcome: Improved bio-security protocols for sensitive island environments; and

Procedures:
1) Generate a genetic "provenance database" for rats on offshore islands and at major ports servicing shipping that has the potential to visit sensitive island environments.
2) Where new rat incursions onto islands are identified, samples queried against the database to determine their source, and to establish the likely route of entry.
3) Improve bio-security protocols by refining quarantine procedures in light of information on route of entry.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Facts from faeces: DNA tools for quantifying the effectiveness of predator control in Western Australia.

Key staff:
DEC – Morris, Marlow, deTores, Algar
CSIRO – Berry (ex. Invasive Animals Cooperative Research Centre)

Project investment and timeframe:
This five-year project involved collaboration between The Department of Environment and Conservation, The Invasive Animals Cooperative Research Centre (CSIRO a partner), and The University of Western Australia.

It supported 2.5 postdoctoral researchers, technical staff, and a leadership team of four DEC researchers.

Current status:
This project consisted of four "Demonstration Sites" in Western Australia where the efficacy of predator control was tested. In addition to standard field methodologies, we pioneered the use of non-invasive DNA analysis of faecal and hair samples to provide quantitative estimates of fox and cat abundance before and after standard control operations.

Data collection is complete, and the project is nearing the completion of the analysis and publication phase.

Future directions:
The project was revelatory in many ways (see outcomes below), and its success means we anticipate it will impact how future predator control strategies operate, and will lead to an increasing uptake of DNA technologies for monitoring invasive and native animals in Western Australia and elsewhere.

We anticipate that the data on rates of fox population recovery and changes in spatial ecology (see below) could be used to build a model of optimal fox control strategies for the rangelands.

We plan to extend these methodologies to monitoring the effectiveness of feral cat and rat eradication from offshore islands (see Project Statement).

Outcomes and management implications:
1) The first clear indication that feral cats play a significant predatory role for medium sized native mammals. ***Implication***: cats must also be targeted by control programs.
2) Provided arguably the first quantitative assessments of the impact of poison baiting on the abundance of foxes. ***Implication***: cost-benefit analysis of poison baiting regimes can be achieved.
3) Documented clear behavioural changes in predator populations in response to poison baiting (e.g. changes to social dynamics, and spatial ecology). ***Implication***: Optimal control programs should adjust strategies for follow-up operations.
4) Poison baiting reduces fox abundance by over 95% in the rangelands. ***Implication***: existing poison baiting programs in the rangelands are effective.
5) Rangeland fox populations recover very slowly from poison baiting. ***Implication***: The optimal period between control programs may be close to 12 months in the rangelands.
6) Wheatbelt fox populations recover rapidly from poison baiting. ***Implication***: There is extreme heterogeneity in the effectiveness and optimal periodicity of poison baiting in Western Australia. One size does not fit all!

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Invertebrate inventories – Pilbara Biological Survey

Key staff:
DEC: Nadine Guthrie, Brad Durrant, Norm McKenzie, Stephen van Leeuwen
CSIRO: Tom Weir, Stephen Shattuck, Kim Pullen

Project investment and timeframe:
Commenced in 2002 with the ANIC's Pilbara Invertebrate Survey within Karijini National Park. Bulk of activity completed in 2010 with publication of DEC's Pilbara Biological Survey ground beetle paper – *Localised and regional patterns in ground-dwelling beetle assemblages in a semi-tropical arid zone environment* (N.A. Guthrie, T. Weir and K. Will).

Current status:
Ongoing - Guthrie is currently liaising with Shattuck over the identification of Pilbara epigean ants and the subsequent distribution of voucher collections.

Future directions:
Ongoing collaboration between agencies anticipated as new bioregional scale biodiversity surveys are undertaken. Should the mainland Kimberley be the next bioregion targeted for survey invertebrates (e.g. land snails, earthworms, ground spiders, ants, scorpions) will be an important biotic group that will be sampled.

A Kimberly bioregional scale survey involving invertebrates would complement the research endeavours of Edwards & Didham in respect to Metagenomics/ecogenomics.

Challenges currently facing survey program in respect to ground invertebrates is comprehensively sampling this biota while minimizing vertebrate by-catch. Animal ethics considerations (minimize by-catch, reduce suffering) and a desire to ensure both invertebrate and vertebrate specimens are viable for future molecular investigations is a significant threat to the continued utilization of invertebrates inventories in biological survey.

Outcomes and management implications:
Invertebrates, in particular those which exhibit some degree of site fidelity, are reasonably abundant and are supported by a sound taxonomic understanding, add significant value in understanding how biodiversity is partitioned across the landscape. They are a very valuable group of organism to include in an overall species by site matrix designed to identify patterns in community arrangement across the landscape.

In the Pilbara Survey they are an integral part of the species by site matrix which will be used to generate predictive model of community distribution across the landscape and for assessing the CAR of the existing conservation reserve system.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Biodiversity Assessment and Management

Key staff:
CSIRO: Leo Joseph, David Yeates, Stephen Cameron
WA DEC: Allan Burbidge; Kevin Thiele, Margaret Byrne

Project investment and timeframe:
CSIRO has already invested substantially in field and laboratory analyses and collections care for WA material and the temporal scope for this work to continue is at least decadal.

Current status:
1. Joseph, Yeates and Cameron have already initiated faunal inventory and evolutionary analyses in various parts of Western Australia, such as East Kimberley and far south-west. It is projected that these will extend to the Great Western Woodlands and central eastern interior of the state.

2. We are very keen to expand these projects to include adaptational perspectives.

Future directions:
We are very keen to see these move into comparative phylogeographic and biogeographic analyses done in conjunction with predictive niche modelling to better understand past, present and future distribution of genetic diversity on the landscape. Identification of refugia is an example of a specific topic to address. Central to this is a perspective centred on genetic lineages rather than traditional taxonomically defined species though they may of course overlap. This recognizes high levels of cryptic diversity that molecular analyses are constantly revealing.

The resources of CSIRO's Transformational Biology Capability Platform should help here in bringing genomic level understanding to adaptive genetic variation in both plants and animals.

Outcomes and management implications:
Conservation and management of diversity under climate change and other environmental change can only be better informed and guided with as good a knowledge as possible of how genetic diversity is distributed across the landscape.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Metagenomics/Ecogenomics

Key staff:
CSIRO: Owain Edwards, Chris Hardy
WA DEC: to discuss

Project investment and timeframe:
To be developed. Potential exists at one possible site, Argyle in the East Kimberley, to continue to 2025.

Current status:
Studies to date have demonstrated CSIRO's capability in using ecogenomic tools and methodology to understand impacts of pollution and invasives on community composition from scales of microbial to vertebrates.

Future directions:
Ecogenomics has much potential in being applied to rehabilitation of mine sites.

Outcomes and management implications:
These relate to obligations of the mining industry to demonstrate rehabilitation has been successfully achieved.

DEC – CSIRO COLLABORATION
PROJECT STATEMENT

Project title:
Change across large scale environmental gradients

Key staff:
CSIRO: Leo Joseph, David Yeates, Stephen Cameron, Adam Slipinski, Rolf Oberprieler, Owain Edwards, Chris Hardy
DEC: Margaret Byrne, Stephen van Leeuwen

Project investment and timeframe:

Current status:
Essentially planned and not yet active.

Future directions:
The project would explore the potential of genomics methodologies in understanding gene expression in natural populations in changing environments. The sharp environmental gradients in southern WA are an ideal opportunity to explore this on an experimental basis. The project has potential to bring the study of natural selection at the molecular level to populations in rapidly changing environments. New kinds of specimen collections are required because of the need to study RNA not DNA.

Outcomes and management implications:
This “project” has potential to develop profoundly novel perspectives in which our science can guide and contribute to management. By identifying genes of ecological relevance and how those genes function in different environments and different species, translocation strategies can be better informed, for example.