# DEC – CURTIN

# STRATEGIC DIRECTIONS WORKSHOP

## WESTERN AUSTRALIAN CONSERVATION SCIENCE CENTRE
## DEPARTMENT OF ENVIRONMENT AND CONSERVATION
## KENSINGTON

**Monday 18 June 2012**

Department of Environment and Conservation

CIBC Curtin University

# AGENDA

## DEC – CURTIN
## Strategic Directions Workshop

**Date:** Monday 18 June 2012

**Time:** 1 pm to 4.30 pm

**Venue:** **Purnululu Meeting Room**
Western Australian Conservation Science Centre (WACSC)
Department of Environment and Conservation
17 Dick Perry Avenue, Kensington WA 6151

**Program:**

| | |
|---|---|
| 12.00 | Lunch |
| 12.30 | Welcome and outline of the workshop<br>Areas of research focus for DEC and Curtin<br>Brief summary/update on existing projects |
| 2.00 | Group discussion:<br>• identification of strengths of each group/ key areas for collaboration |
| 3.00 | Afternoon tea |
| 3.20 – 4.30 | Group discussion:<br>• opportunities for capitalising on existing partnerships<br>• new initiatives / opportunities for new synergies<br>• workshop outcomes and strategy for implementation |

# DEC – CURTIN

## List of Attendees at

## STRATEGIC DIRECTIONS WORKSHOP

| | Name | Affiliation | Email Contact Details |
|---|---|---|---|
| 1 | Dr Margaret Byrne | DEC | margaret.byrne@dec.wa.gov.au |
| 2 | Dr Neil Burrows | DEC | neil.burrows@dec.wa.gov.au |
| 3 | Dr David Coates | DEC | dave.coates@dec.wa.gov.au |
| 4 | Mr Paul van Heurck | DEC | paul.vanheurck@dec.wa.gov.au |
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| 7 | Dr Stephen Van Leeuwen | DEC | stephen.vanleeuwen@dec.wa.gov.au |
| 8 | Mr Keith Morris | DEC | keith.morris@dec.wa.gov.au |
| 9 | Dr Colin Yates | DEC | colin.yates@dec.wa.gov.au |
| 10 | Grant Wardell-Johnson | Curtin University | G.Wardell-Johnson@curtin.edu.au |
| 11 | Kylie Munyard | Curtin University | K.Munyard@curtin.edu.au |
| 12 | Christine Cooper | Curtin University | C.Cooper@exchange.curtin.edu.au |
| 13 | Mark Gibberd | Curtin University | M.Gibberd@exchange.curtin.edu.au |
| 14 | Mervyn Lynch | Curtin University | M.Lynch@curtin.edu.au |
| 15 | Jonathan Majer | Curtin University | J.Majer@curtin.edu.au |
| 16 | Laco Mucina | Curtin University | L.Mucina@curtin.edu.au |
| 17 | Richard Harris | Curtin University | R.Harris@curtin.edu.au |
| 18 | Tianhua He | Curtin University | Tianhua.He@curtin.edu.au |

# DEC – CURTIN WORKSHOP

Western Australian Conservation Science Centre, Kensington

## Index of Projects

| Current Projects | Key Staff |
|---|---|
| Protecting the safe havens: will granite outcrop environments serve as refuges for flora threatened by anthropogenic climate change? | DEC - C Yates; M Byrne<br>Curtin - G Wardell-Johnson; G Keppel; L Mucina; T Schut<br>Others - K Van Niel (UWA); S Hopper (Kew); S Franklin (Trent) |
| Towards a Landscape Conservation Culture – broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems. | DEC - N Burrows<br>Curtin - G Wardell-Johnson<br>Others - K Van Niel (UWA); D Pullar (University of Queensland |
| Impacts of Goats in Rangeland Ecosystems. | DEC - D Blood<br>Curtin - R Harris |
| **Proposed Projects** | **Key Staff** |
| Groundwater outcropping as ancient refugia: conserving phylogenetic relicts in two Mediterranean hotspots. | DEC - C Yates; M Byrne<br>Curtin - G Wardell-Johnson<br>Others - W Bond (UCT South Africa); P Horwitz (ECU) |
| Adaptation or transformation? Biodiversity consequences of hydrological change and jarrah forest management. | DEC - C Yates; G Stoneman<br>Curtin - G Wardell-Johnson<br>Others - K Van Niel (UWA); J Croton (Consultant); A Grigg; M Daw (Alcoa); S Vlahos (Worsley); W Bond (UCT South Africa) |
| Carbon and microclimate dynamics in forest refugia under climate change. | DEC - C Yates<br>Curtin - G Wardell-Johnson; T Schut<br>Others - K Van Niel (UWA); C Dean (UTAS) |
| **Student Projects** | **Key Staff** |
| Towards an explanation for changed canopy height in mature south-western forests. | Student - J Chapman<br>Curtin - G Wardell-Johnson; T Schut<br>DEC - L McCaw; C Yates<br>Others - W Bond (UCT South Africa) |
| Using a plant functional trait approach to determine climate-change driven dynamics of plant community assembly on granite outcrops of Western Australia. | Curtin - G Wardell-Johnson; L Mucina; G Keppel |
| Regional Variability in Salmon Gum Communities in the Great Western Woodlands. | Student – J Harvey<br>Curtin - L Mucina<br>DEC - S van Leeuwen; DEC Kalgoorlie<br>Others - S Prober (CSIRO); Wildflower Society of Western Australia |

| Title of Student Projects | Key Staff |
|---|---|
| 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. | Student - P van Heurck<br>Curtin - J Majer<br>DEC - I Abbott |
| Spatial and temporal characterisation of ecosystems in landscapes surrounding granite outcrops. | Student - G Alibegovic<br>Curtin - G Wardell-Johnson; T Schut<br>DEC - C Yates |
| Ecological and evolutionary drivers of taxonomic and phylogenetic beta diversity in the old landscapes of Southwest Australia and the Cape of South Africa. | Student - G Campbell-Young<br>Curtin - L Mucina<br>DEC - C Yates |
| Physiological impacts of mammal trapping and transport protocols. | Curtin - C Cooper<br>DEC - A Wayne<br>Others - P Withers (UWA); C Rafferty (Whiteman Park) |
| Pathogen driven change in species-diverse woodlands of the Southwest Australian Floristic Region: A hybrid ecosystem in a Global Biodiversity Hotspot. | Student - C Bishop<br>Curtin - G Wardell-Johnson<br>DEC - N Burrows |

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

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

**Key staff:**
Curtin - Grant Wardell-Johnson, Gunnar Keppel, Laco Mucina, Tom Schut
DEC - Colin Yates, Margaret Byrne
Others - Kimberly Van Niel (UWA), Stephen Hopper (Kew), Steven Franklin (Trent)

**Project investment and timeframe:** ARC Linkage (2010-2012), Curtin, UWA, DEC, AAMHatch, ARC ($330 over 3 years)

**Background/aim:**
Identifying the characteristics and occurrence in landscapes of potential climate refuges is a key international climate change research agenda that requires transdisciplinary approaches in the ecological, evolutionary and spatial sciences. In this project we use a transdisciplinary approach to understand past dispersal and contraction of species and scalar relationships with regional landscape components to contribute to developing effective Climate Change Integrated Conservation Strategies.
We propose that granite outcrops (GOs) provide important climate refuges for plant species and ecological communities. We investigate the potential of GOs and their associated environments to act as refugia in the face of anthropogenic climate change across the south-western Australian climatic gradient. We investigate the biophysical mechanisms facilitating persistence of species and ecological communities in GO climate refuges by asking the following questions:

- 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?

**Current status:**
Digital Elevation Models (DEMs) have been derived from LiDAR imagery flown over 28 granite outcrops. Fine-scale multispectral scanner imagery has been collected at the same sites. Extensive field work has been undertaken obtaining micro climate data on 6 granite outcrops, and assessing vegetation communities in replicated quadrats (10 replicates in each of 3 habitats) on 15 granite outcrops. Detailed floristic surveys of herb fields have been undertaken at Boyagin Rock. Genetic analysis of two species common across granite outcrops is being finalised. A major review of Identification of Refugia and a paper identifying priorities in conservation planning have been published. Several other papers on specific aspects of the project (e.g. vegetation mapping) have also been prepared or published. Several PhD and Masters projects are underway.

**Future directions:**
Build Refugia into conservation planning, and develop the refugia research and management direction in the context of anthropogenic climate change. Publish several major data papers over coming months and into next year.

**Anticipated outcomes and management implications:**

- Identification of refugia
- Understanding of spatial and temporal pattern and process in refugia
- Prioritised management of refugia
- Changed management regimes to suit refugia and the conservation of the south-western biota

## DEC – CURTIN UNIVERSITY COLLABORATION
## PROJECT STATEMENT

**Project title:**
Towards a Landscape Conservation Culture – broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems

**Key staff:**
Curtin - Grant Wardell-Johnson
DEC – Neil Burrows
Others – Kimberly Van Niel (UWA), David Pullar (UQ)

**Project investment and timeframe:**
ARC Linkage (2006-2009), Curtin, UWA, DEC, ($222 over 3 years)

**Background/aim:**
This project in south-western Australia develops an integrated framework to interpret knowledge about landscape processes and future trajectories of species and assemblages at different spatio-temporal scales. A synthesis of data obtained through repeated biological surveys and remote sensing, with spatial data handled through GIS is used in an explanatory modeling approach to make predictions under different disturbance regimes. Models built from combined spatial layers exhibiting continuous variation in environmental variables will provide area-class maps at different scales, allowing the portrayal of uncertainty associated with vegetation units - a considerable innovation over maps depicting homogenous discrete zones.

Aims

1. To develop an integrated framework to interpret knowledge about natural landscape processes. This can then be used to anticipate their future trajectories under a range of disturbance regimes and conservation policies.
2. To develop methodologies for the synthesis of data obtained through biological surveys (at a plot scale) and remote sensing (at a landscape scale), with spatial data handled through geographical information systems.
3. To use an explanatory modeling approach to test ecological theories and assess current and proposed conservation policies that interpret data and make model-based predictions of species and assemblage distributions under different disturbance scenarios.
4. To resample selected permanently located quadrats established and assessed 12-15 years ago to derive and test temporal models specific to particular community types.

**Current status:**
A final report was delivered to the ARC. Two PhDs have been completed and numerous publications have resulted. However, there remain several outstanding publications currently in preparation and one PhD thesis still to be completed. Further, there remain several directions in conservation biology to be further championed towards management outcomes.

**Future directions:**
Build the tingle mosaic into refugia planning, and develop the refugia research and management direction in the context of anthropogenic climate change. Publish several major data papers over coming months and into next year.

**Anticipated outcomes and management implications:**

- Increased recognition of the conservation significance of the Tingle Mosaic.
- Understanding drivers of distribution patterns in relictual trees.
- Understand disturbance and resilience in relation to *Phytophthora* in the region.
- Changed management regimes to suit refugia and the conservation of the south-western biota.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Impacts of Goats in Rangeland Ecosystems

**Key staff:**
Curtin – Richard Harris
DEC – Was Dave Blood, Geraldton, currently unfilled position

**Project investment and timeframe:**
Geraldton Iron Ore Alliance – 40 K annually (2 years funding to date, confirmed until end of 2012 but likely ongoing. Logistic support from individual Midwest iron ore mines – particularly Crossland Resources and Extension Hill

**Background/aim:**
Feral goats present a potential threat to plant communities given the large number of plant species that are palatable to them and their ability to browse and graze in inaccessible areas such as in trees or in dense thickets. Control of feral goats is a complex issue. While they are a major environmental and agricultural pest, they are seen by some to have commercial value. Feral goat control programs also need to be coordinated with other activities that may be taking place, including the on-ground protection of threatened plants and animals and control of native species such as kangaroos and invasive species such as rabbits.
A key question is how responsive is the vegetation to goat removal, and if goats are managed do other herbivores remaining in the Rangeland maintain its degraded state?
The Department of Environment and Conservation have established 27 enclosure plots in the rangelands inland from Geraldton with matching open plots to investigate vegetation recovery following destocking and water removal on ex pastoral lease stations. The vegetation monitoring setup follows well established monitoring protocols for rangeland perennial vegetation.
This project aims to establish additional exclosure plots in areas where higher goat densities will be maintained and add additional baseline measures to both the DEC and newly established plots for future measurement of ecosystem changes.

**Current status:**
Established addition plots which are in the process of being fenced. Added monitoring of herbivore abundance (via scat transects), annuals and grasses to all plots, and captured initial high resolution spectral imagery for the new sights. Regular (twice annually) monitoring trips undertaken

**Future directions:**
Ongoing monitoring of annuals and perennials. Tag and follow selected seedlings. Incorporate projects by third year and honours students into the study into the study.

**Anticipated outcomes and management implications:**
Determine if feral goat management, in the presence or absence of management of other herbivores leads to detectable ecosystem recovery.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Groundwater outcropping as ancient refugia: conserving phylogenetic relicts in two Mediterranean hotspots

**Key staff:**
Curtin - Grant Wardell-Johnson
DEC - Colin Yates, Margaret Byrne
Others – William Bond (UCT –South Africa), Pierre Horwitz (ECU)

**Project investment and timeframe:**
Draft ARC Linkage, Curtin, DEC, UCT (South Africa)

**Background/aim:**
Several recent hypotheses have been presented to explain the high levels of diversity in the high rainfall fynbos and south-western Australian Global Biodiversity Hotspots. Groundwater outcropping has been noted in the Blackwood Plateau and Cape Point areas of these two hotspots – both associated with high levels of phylogenetic richness. Does the long-term presence of these areas of groundwater outcropping provide a better explanation for these high levels of phylogenetic richness than current explanations concerning stable climate, soil and fire?

We investigate phylogenetic explanations for richness across an array of groundwater outcropping areas at Cape Point and in the Blackwood Plateau of south-western Australia.

**Current status:**
A database of 80 400 $m^2$ plots has been compiled from the Blackwood Plateau including both groundwater outcropping and non-outcropping areas. Maps of groundwater outcropping have been prepared based on the Yarragadee project. A similar database exists for macro-invertebrates.

**Future directions:**
Apply for ARC Linkage.

**Anticipated outcomes and management implications:**
- Contribute to explanations of the phylogenetic richness of two global Biodiversity hotspots.
- Enable prioritisation of refugial habitat in the face of on-going climate change.
- Understanding of spatial and temporal pattern and process in ancient refugia.
- Changed management regimes to suit ancient refugia and the conservation of the south-western biota.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:** Adaptation or transformation? Biodiversity consequences of hydrological change and jarrah forest management

**Key staff:**
Curtin - Grant Wardell-Johnson
DEC - Colin Yates, Geoff Stoneman
Others – Kimberly Van Niel (UWA), James Croton (Consultant hydrologist), Andrew Grigg, Matthew Daw (Alcoa), Stephen Vlahos (Worsley), William Bond (UCT –South Africa)

**Project investment and timeframe:** Unsuccessful ARC Linkage prepared and submitted 2011, current draft linkage in preparation

**Background/aim:**
The availability of water in space and time has a profound influence on the distribution of biodiversity and the dynamics of terrestrial and aquatic ecosystems. In forest ecosystems world-wide, ecohydrological processes are being altered at unprecedented rates by the interactive effects of climate change and management history, with potentially far-reaching consequences for forest biodiversity. The extent to which forest ecosystems will adapt or be transformed by evolving hydrological regimes is currently poorly understood.
The Jarrah Forest Bioregion is a model system for investigating the influence of forest management history and anthropogenic climate change on the ecohydrology of forest ecosystems. The area has been experiencing an increasing frequency and magnitude of climate change events. Further, a legacy of sustained timber production and mining has resulted in large areas of regrowth. Both the higher evapotranspiration demand of the regrowth forest and the accelerating events of climate change have contributed to a new hydrological regime, with pronounced declines in groundwater levels and reductions in stream-flow. The consequences for the region's biota are potentially profound, but poorly understood.
The south-western Australian biome equates to the patterns predicted by Schimper in global biome modelling. However, this situation is unusual, in that for many areas of the world the presence of fire has led to biome shifts. Why have these shifts not been observed in south-western forests?
Using a large dataset from the northern jarrah forest (> 20 000 plots), and new approaches to measuring forest structure, we investigate the influence of jarrah in ecosystem dynamics to understand changes in structure, composition and function with gradients of water availability. We then develop integrated models to evaluate climate change, jarrah forest management and water use impacts on biodiversity. Our specific aims are to 1) spatially map biodiversity, jarrah forest structure and density, and hydrological data in the jarrah forest; 2) Determine the degree of hydrological dependency of various components of the biota by relating spatial-temporal patterns of hydrological systems to functional traits, behaviour and biodiversity patterns; 3) Develop and use models to identify water-dependent refugia across the region and use climate projections and hydrological data to predict the persistence of these refugia and associated taxa in the northern jarrah forest.

**Current status:** Several large datasets are currently being complied, consisting of over 20 000 quadrats. A team of researchers has been assembled and a draft grant application prepared.

**Future directions:** Submit ARC Linkage in November 2012, continue to build database and prepare to commence main activity in July 2013.

**Anticipated outcomes and management implications:**
- Identification of refugia
- Understanding of spatial and temporal pattern and process in refugia
- Prioritised management of refugia in relation to hydrological change
- Determine changed management regimes to suit refugia and the conservation of the biota in the jarrah forest in relation to climate change.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Carbon and microclimate dynamics in forest refugia under climate change

**Key staff:**
Curtin - Grant Wardell-Johnson, Tom Schut
DEC - Colin Yates
Others - Kimberly Van Niel (UWA), Christopher Dean (UTAS)

**Project investment and timeframe:**
ARC Linkage currently under preparation

**Background/aim:**
Globally, Australia's forest area ranks seventh (~150 $km^2$) and its open woodlands first (~135 $km^2$) Australia's 'tall open-forests' have the highest biomass per unit area (C-density) of any forest. However, quantification of their C dynamics (including stocks) remains inadequate. This is exemplified in the remote forests of the south-western (SW) Australian, Global Biodiversity Hotspot, which has only a broadscale C account and no C allometrics for large or non-commercial trees — precluding accurate C accounting. The Warren Bioregion in particular (0.83 Mha) contains most of the 0.25 Mha of tall open-forest and the most C-dense old-growth forests in the western third of the continent.
Refugia are of increasing importance for conservation planning under climate change. Not only does the Warren Bioregion exhibit high C-density, but it is also the most important centre for ancestral plant, vertebrate and invertebrate taxa confined to high rainfall zones in the western third of the continent. This bioregion provides cascading scales of refugia of international significance. Modelling shows that the highly vulnerable Warren Bioregion lies within the most vulnerable of the world's Mediterranean-climate regions. Understanding the extent to which C stocks can be resilient and provide refugia that are crucial to biodiversity conservation under forecast climate change is a highly significant research agenda.
We will investigate microclimate and C dynamics using integrated models at the landscape-level to evaluate climate change impacts and adaptation in the refugial environments of the Warren Bioregion, of south-western Australia. We will link data from remote sensing, forest mensuration, forest ecology and biogeochemical modelling: developing biodiversity scenarios under climate change. Our four specific aims are:
1. Construct allometrics for species that contribute significantly to C pools, and scale-up.
2. Derive microclimate patterns in the four dimensions of space and time.
3. Apply models to portray C and microclimatic dynamics and dependencies at the landscape level.
4. Determine the prognosis (i.e. health and condition) of the major components of biomass.

**Current status:**
ARC Discovery submitted, ARC Linkage more broadly linked with refugia being prepared for November 2012.

**Future directions:**
Build Refugia into conservation planning, and develop the refugia research and management direction in the context of anthropogenic climate change.

**Anticipated outcomes and management implications:**
- Understanding of biomass and identification of refugia.
- Understanding of spatial and temporal pattern and process in refugia.
- Prioritised management of refugia.
- Management regimes to suit refugia and the conservation of the south-western biota.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Towards an explanation for changed canopy height in mature south-western forests

**Key staff:**
Student - Jane Chapman
Curtin - Grant Wardell-Johnson, Tom Schut
DEC – Lachlan McCaw, Colin Yates
Others – William Bond (UCT –South Africa)

**Project investment and timeframe:**
Current third-year and honours student project with a view to preparing an ARC Linkage in November 2013, Curtin, DEC, UCT (South Africa)

**Background/aim:**
A GIS database has been prepared of significant trees in south-western Australia. Aerial Photographic Interpretation has been used to prepare detailed representation of canopy structure and height within the forests of south-western Australia. A pilot survey using a Leica CT 10 scanner suggests a considerable drop in canopy height from old-growth to that in mature jarrah and karri regrowth forests. However, the generality of these findings are not yet clear, nor have explanations for this changed structure yet been proffered. We examine the generality of the findings and test whether 1) nutrient depletion, 2) silvicultural practise (and hence growth characteristics), 3) climate change (ie hydrological or temperature explanations), 4) fire or 5) changed characteristics of the forest associated with wildlife (i.e. reduction in woylie numbers) provide better explanations in different forest types (specifically jarrah and karri forest). The implications of changed canopy structure under climate change are also addressed.

**Current status:**
DEC and Curtin have produced a GIS database of significant trees of the production forests of south-western Australia. DEC has produced API maps of stand structure prior to the period of intensive logging in these forests. Curtin has a ground-based LiDAR scanner (a Leica CT10) to enable fine scale-portrayal of stand structure. A third year project has commenced at Curtin (Jane Chapman) to test the utility of the equipment and to understand ancient tree architecture.

**Future directions:**
Build canopy structure investigations in association with the 2014-2023 forest management plan towards preparation of ARC Linkage, November 2013.

**Anticipated outcomes and management implications:**
- Understanding of spatial and temporal pattern and process in south-western forest canopys in both production forests and the conservation estate.
- Incorporate understanding of canopy structure and function in production forests for better conservation outcomes.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Using a plant functional trait approach to determine climate-change driven dynamics of plant community assembly on granite outcrops of Western Australia

**Key staff:**
Student - Gianluigi Ottaviani
Curtin - Grant Wardell-Johnson; Ladislav Mucina; Gunnar Keppel
DEC - Lachlan McCaw, Colin Yates

**Project investment and timeframe:**
Endeavour Europe Award (first year stipend), CIPRS (fee waiver for the entire length of PhD project, second and third year stipend)

**Background/aim:**
Global climate change is predicted to lead to aridification and increased fire frequency and intensity in the SWAFR, a global biodiversity hotspot. In this region many granite outcrops (GOs) are scattered around and are hypothesized to act as climatic refugia for the biota in times of increased drought stress. Refugia are defined as places in which species can retreat to, survive in and spread out under more favourable environmental conditions. The PhD project aims to investigate the ecological processes ruling the plant communities on GOs, using a plant functional trait (PFT) approach. PFTs (morphological and/or physiological plant attribute connected to system functioning) have the capacity to detect ecological mechanisms and to predict impacts (response and feedback effects) of environmental shifts on vegetation. Therefore, the research addresses to reveal the plant community assembly of GOs, to develop a methodological approach to identify refugia (as GOs are considered as such) and to anticipate how climate change will affect GOs' plant communities.

**Current status:**
During the first nine months of the project, I have done some preliminary fieldwork, I have worked on PhD proposal drafting and I have submitted the summary of the project for confirmation, reaching it on February 2012. I am now focused on writing study-related papers regarding the novelty to apply a trait approach to identify refugial plant communities.

**Future directions:**
In the next months I will submit the research-related papers, starting the data-input for the generation of the trait database to be used for the functional analyses. During the all spring I will be in the fieldwork for data collection.

**Anticipated outcomes and management implications:**
The PhD project will get to a better understanding of ecological patterns within GOs plant communities, detecting their assembly rules. This trait-based approach represents a research breakthrough because will allow to identify refugial plant communities, and predicting climate-change driven dynamics on such vegetation. The research outputs could be used for climate-change management of refugia, having knowledge of which could be the shifts (community responses and effects on system functionality) on GOs plant communities.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Regional Variability in Salmon Gum Communities in the Great Western Woodlands

**Key staff:**
Student - Judith Harvey
Curtin - Ladislav Mucina
DEC - Stephen van Leeuwin; DEC Kalgoorlie
Other - Suzanne Prober (CSIRO); Wildflower Society of WA

**Project investment and timeframe:**
Australian Post Graduate Award Scholarship, Curtin Post Graduate scholarship, Curtin operating, DEC Stipend, DEC Operating, Dahl Trust and Wildflower Society (in kind). Total $105.8K over 2 yrs
July 2011 to June 2013

**Background/aim:**
Salmon Gum (*Eucalyptus salmonophloia*) is an iconic WA tree extending across the Wheatbelt and the Great Western Woodlands. There is a growing need for information about the biodiversity of the GWW due to the expansion of mining activities, its recognition as the largest remaining temperate eucalypt woodlands on earth and the amazing diversity of Eucalyptus species found there.
Previously surveys have concentrated on areas such as the banded iron formation and greenstone belts where the mining interests lies. This survey of about 100 sites across the GWW aims to fill some gaps and will assess the regional variability in structure and composition of the woodland communities and relate this to soil properties, landscape position and climate. The influence of timber cutting and grazing will also be considered. Then the data from the GWW sites will be compared with data previously collected in the Wheatbelt. Finally mapping tools will be developed based on the site data and available GIS and remotely sensed layers.

**Current status:**
A third of the sites have been sampled, plants identified and soils analysed. These will soon be analysed using a variety of statistical methods. The rest of the sites will be sampled in May, September and October 2012. A stratification of GIS layers is assisting with sample site selection and will be integral in the mapping exercise. For more information see http://salmongumgww.wordpress.com/

**Future directions:**
1. Possible extension into a PhD may test the influence of land use activities, examine leaf traits or further develop mapping tools.
2. The preparation of a preliminary vegetation map of the GWW and design of a field sampling program.

**Anticipated outcomes and management implications:**
- A major outcome of this project will be a description and enhanced understanding of the patterns and processes governing the distribution, composition and structure of Salmon Gum communities in the GWW. This will assist land managers in the understanding of the impact of fire, grazing, timber cutting and mining activities, guide restoration activities and inform recreational visitors, students and residents.
- The development of mapping tools is aimed at producing a preliminary SG woodland map. Vegetation maps are integral in conservation land management; providing a basis for understanding fire behaviour and suppression, fauna distribution, mine restoration.
- Permanently marked sites may be used for long term monitoring or as a basis for fauna studies e.g. birds.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**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

**Key staff:**
Student - Paul van Heurck
Curtin - Jonathan Majer
DEC - Ian Abbott

**Project investment and timeframe:**
Alcoa Foundation Funding, PhD project 2006 – 2013

**Background/aim:**
Identifying the characteristics and occurrence in landscapes of potential climate driven fire-refuges is part of a key international climate change research agenda. In this PhD project I am using the changes in the three components of biodiversity (taxonomic, structural and functional diversity) of beetle assemblages to understand the habitat and refuge requirements created within extremes of possible future fire regimes ranging from fine grained mosaics to broadscale canopy defoliating wildfires which could impact on the regional landscape containing granite outcrops (GOs).

**Current status:**
In March 2003 an intense wildfire in heavy fuels burnt approximately 20 000 ha of the Mt Roe National Park (NP), north-east of Mt Frankland. The rapid southward spread of this wildfire was halted along the northern boundary of London forest block, patchy prescribed burnt in the previous spring. The contrasting intensities at which these adjoining forests blocks were burnt has provided an opportunity to compare the fire impact on the biodiversity of their invertebrate communities. The six year inventory of the beetle species of this study area indicate beetle species represent up to 21.5% of the invertebrate species in these Mt Roe NP communities. Of the 23,100 invertebrate specimens currently sorted, beetles represent 445 species. Of these 220 beetle species are rarely collected and may prove to be Short Range Endemics (SRE). These rare beetles appear to be mostly fire-habitat specific with 97 species collected only from the patchy mosaic fire regime and another 64 species only collected from wildfire burnt habitats. I'm currently analysing and drafting Chapter 3 of my thesis, in which Appendix 1 represents a prodromus of the 445 beetles species inventoried from the Mt Roe NP. Each of these beetle species is listed with a set of life history attributes including its current "Fire Niche". Future thesis chapters will compare and contrast the impacts of the 3 different fire regimes on all 3 components of beetle biodiversity, in addition to chapters on improving sampling methods based on different sampling efforts, spacing and micro-habitats.

**Future directions:**
Adapt and improve current and future multidisciplinary biodiversity forest monitoring protocols to inventory other southern forest vegetation complexes. Build fine grained fire mosaics and the protection of refugia into conservation planning, and develop the fire mosaic research and management direction in the context of anthropogenic climate change. Complete the analysis and write-up of this PhD thesis over coming months and commence publishing papers in future years.

**Anticipated outcomes and management implications:**
- Identification of beetle fauna of Mt Roe National Park.
- Understanding of fire impacts on taxonomic, structural and functional diversity of endemic beetles.
- Adapt management regimes to create habitats and refugia for the conservation of the south-western invertebrate species.
- Assist in ground truthing the mapping of vegetation and refugia fire age using LandSat imaging.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:** Spatial and temporal characterisation of ecosystems in landscapes surrounding granite outcrops

**Key staff:**
Student - Goran Alibegovic
Curtin - Tom Schut; Grant Wardell-Johnson

**Project investment and timeframe:** ARC Linkage, ARC, Curtin; projected completion 2015

**Background/aim:** This study examines the characteristics of granite outcrops to identify potential climate change refugia for flora of the southwest Western Australian biodiversity hotspot. Three hypotheses about refugia habitats near granite outcrops were formulated (Wardell-Johnson *et al.*, 2009): 1) they provide more water and nutrient resources 2) habitats on and near granite outcrops are more diverse than in the surrounding landscape and 3) granite outcrops with a large diversity of habitats are more likely to contain refugia. This study aims to develop a methodology to test these hypotheses with remotely sensed imagery at the landscape scale. Firstly, all granite outcrops in south-west WA will be mapped. Secondly, patterns of heterogeneity will be quantified to identify habitat and plant species diversity. Thirdly, phenological characteristics will be quantified to identify habitat differences in growing conditions and responses to recent climate change. Finally, measures of heterogeneity, plant species diversity and phenology are integrated to identify potential refugia. To this end, seasonal trends will be analysed and image heterogeneity will be related to habitat diversity. The methodology will be developed on 3 and tested and validated on 2 other selected outcrops.

**Current status:**
Nearing completion of the first objective to map the granite abundance in the area of interest. Identified relevant satellite imagery and existing ancillary data. The methodology to map granite abundance was developed using the moderate spatial and spectral resolution imagery i.e. TM data and cross checked with existing high resolution aerial RGB imagery and ancillary geological information. Groundtruthing data was compiled from the high resolution RGB and LiDAR data, processed by others working in the refugia project. A number of steps to map the granite abundance are identified.
Firstly, spectral separability of granite and its surroundings was evaluated with an ISODATA unsupervised classification, supervised classifications and Principal Components Analyses. Separability of one-off imagery was compared with a combination of summer/winter imagery following the approach developed by CSIRO where ROC (receiver operating characteristics) curves were developed during this phase to assess the quality and accuracy of the masks developed to mask out areas of no interest.
Finally, a supervised classification, using selected features (spectral, textural, topographic or combinations) were applied and compared. Different combinations of data were needed. When the procedure was developed, the model input data were prepared and statistics analysed during the validation phase.
To test model accuracy, Kappa statistics were calculated to measure and quantify the agreement of different classifications. A Kappa statistics larger 0.7 was considered accurate. If methodology developed is of sufficient accuracy then it will be applied to other selected study areas to map granite abundance.

**Future directions:** I will be presenting findings of the objective one at the ARSPC conference in Melbourne in August. I am hoping to start working on the objective two soon after all work on objective one is complete.

**Anticipated outcomes and management implications:**
- Identification of refugia.
- Understanding of spatial and temporal patterns in refugia.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:** Ecological and evolutionary drivers of taxonomic and phylogenetic beta diversity in the old landscapes of Southwest Australia and the Cape of South Africa

**Key staff:**
Student - Gael Campbell-Young
Curtin - Ladislav Mucina
DEC - Colin Yates

**Project investment and timeframe:** Scholarships – APA, CRS and FPA; 3 years

**Background/aim:**
Beta diversity is the spatial turnover or change in species (taxonomic beta diversity), plant functional groups (functional beta diversity), lineages (phylogenetic beta diversity) and the like among sample plots or habitats. Beta diversity captures a fundamental facet of the spatial pattern of biodiversity, therefore turnover and the factors that influence this spatial pattern must be considered in understanding the structure, function and origin of ecological communities. Very old, stable landscapes in which speciation has been allowed to take place over very long periods of time may contain areas of high beta diversity. Beta diversity is remarkably high in the two globally prominent old, stable landscapes of the Southwest Australian Floristic Region (SWAFR) and Greater Cape of South Africa. These regions share many ecological and palaeobiological similarities and are thus ideal platforms for studying beta diversity. The ecological and evolutionary aspects of the emergence of beta diversity are vital for understanding the exceptionally high species diversity in the SWAFR and Greater Cape. Key drivers assumed to promote and maintain high beta diversity include ecological drivers such as stressors (e.g. nutrient-deficient soils and climatic seasonality) and ancient evolutionary drivers including landscape evolution and resulting adaptation mechanisms favouring local persistence (e.g. resprouting, reseeding and limited dispersal of seeds). Prolonged cladogenesis on the old landscapes of the study regions has led to the evolution of suites of locally endemic species, whose ranges are restricted possibly as a result of the isolation caused by dispersal limitation. The resulting persistence of many different species in local areas contributes to high beta diversity, therefore beta diversity, dispersal limitation and endemism are closely linked in these regions. In spite of the importance of beta diversity in understanding the spatial pattern of biodiversity, this component of diversity has received surprisingly limited attention. Hypotheses specifically addressing taxonomic and phylogenetic beta diversity in the context of the SWAFR and Greater Cape are rare. This research aims to explore and describe patterns of taxonomic and phylogenetic beta diversity in the two regions; determine which ecological and evolutionary factors are responsible for driving the high beta diversity; establish how important the drivers are relative to each other; ascertain how beta diversity patterns are influenced by scale; and to assess the practical implications of these findings for biogeography, conservation planning, ecology, evolutionary biology and vegetation mapping in the SWAFR and Greater Cape.

**Current status:**
PhD Candidacy approved; first of two field trips undertaken (South Africa and Western Australia, 2011); field data processed; acquiring data for analyses and beginning analyses; writing up literature review and first three chapters of thesis.

**Future directions:**
Undertake second field trip spring 2012; process field data; continue with data acquisition and analysis; write up chapters of thesis.

**Anticipated outcomes and management implications:**
Maps of beta diversity in SWAFR and Greater Cape; analysis of ecological correlates of beta diversity in the study regions; directional and non-directional beta diversity studies; phylobetadiversity study; beta diversity, endemism and limited dispersal study.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:** Physiological impacts of mammal trapping and transport protocols

**Key staff:**
Curtin - Christine Cooper
DEC – Adrian Wayne
Others – Philip Withers (UWA), Christine Rafferty (Whiteman Park)

**Project investment and timeframe:** Applying for ARC Linkage (Curtin, DEC, Whiteman Park), Pacific Science Foundation, Herman Slade Foundation and other funding

**Background/aim:** The overall aim is to apply physiological and animal management expertise to minimise the impact of trapping and transport protocols on native fauna. Methodology such as trapping, transport and other monitoring may be associated with stress or mortality (Kenward 1987; Jackson 2003; Lemckert et al 2006), and this is clearly undersirable from both conservation and ethical perspectives. Animal welfare is fundamental to ethically sound trapping of wild native fauna, so determining the appropriate precautions and conditions to achieve effective and reliable maintenance of animal welfare during research is of paramount importance. This project will objectively quantify the conditions experienced by fauna during routine live trapping and transport, and assess the physiological impact that these conditions have on the animals. The study will examine how the time spent in the trap, trap placement, trap modification, and transport procedures influence the thermal and physiological stress experienced by the animal, and determine best practise for trapping protocols to minimise this stress.
There are three specific aims of this study:

- To measure the range of environmental conditions within animal traps, relate these to known physioglical responses of commonly-trapped species, and then produce a "best practise" trapping protocol for various habitats to avoid exposing trapped animals to physiologically inappropriate conditions while still optimising trapping efficiency.
- To directly measure the physiolgical effects of standard trapping procedures using body temperature, metabolic rate, ventialtion and corticosteroid levels as indictors of pysiological stress, and develop best-practise approaches to minimising these responses.
- To examine the environmental conditions experienced by animals during transport, relate these to known physiological paramters, examine the physiological stress response of animals to various transport methods and determine long and short term physiolgical consequences.

**Current status:**

- Measurements of environmental conditions in animal traps have been completed (as an honours project) for open woodland habitats. Honours thesis has been completed and submitted and a publication is in preparation.

**Future directions:**

- Submit ARC linkage and other grant applications.
- Submit MS resulting from honours project for publication.

**Anticipated outcomes and management implications:** This project will improve knowledge of the physiological implications of conservation biology practices. Management procedures that are essential for the timely conservation of endangered Australian fauna, along with heightened awareness of animal ethics issues, means that it is imperative that we understand the physiological interactions of these species with the environments to which they are exposed. Understanding the physiological impact of trapping and transport protocols will allow for improved management practises which take into consideration physiological requirements and responses, essential components of an animal's potential for survival and reproduction, and an important ethical consideration. Evidence based protocols contribute not only improved conservation and welfare outcomes, but also improve trapping efficiency.

**DEC – CURTIN UNIVERSITY COLLABORATION**
**PROJECT STATEMENT**

**Project title:**
Pathogen driven change in species-diverse woodlands of the Southwest Australian Floristic Region: A hybrid ecosystem in a Global Biodiversity Hotspot

**Key staff:**
Student - Carly Bishop
Curtin - Grant Wardell-Johnson
DEC - Neil Burrows

**Project investment and timeframe:**
ARC Linkage, DEC in kind

**Background/aim:**
This PhD was part of a larger ARC linkage project titled "Towards a Landscape Conservation Culture – broadening the spatio-temporal scope of ecological studies to anticipate change in Australian forested ecosystems." It aims to explore questions regarding biodiversity management using an integrated landscape-level approach to conservation which looks beyond individual species.

The project asked the question: Does *Phytophthora cinnamomi* infestation result in a novel or hybrid ecosystem characterised by a change in *Banksia* woodland composition, structure and/or function?

Through integrating and utilising current ecological theory and frameworks, the project links concepts and methods in community ecology to explore disturbance and change. This link is often inadequate in ecological literature and requires bridging through application and testing of theory in field situations or novel research. The practical integration and application of Resilience and Novel Ecosystem theory, forms the basis of the project and provides an alternate view of disturbance beyond species-level shifts.

**Current status:**
The project identified that although *Banksia attenuata* woodlands have undergone an irreversible shift in identity (species dominance, beta diversity, stand variables, plant functional trait composition) some original features have been retained including species richness, species diversity and functional diversity. For these reasons, the post-pathogen community identifies as a hybrid ecosystem that is equally speciose despite substantial pathogen-induced shifts. The study documented pathogen-induced changes in vegetation structure, composition and plant functional trait composition. 18 space-for-time transects were established with extensive baseline data was collected including detailed floristics and associated stand variables (canopy cover, basal area, leaf litter).

2 papers published with a synthesis paper in preparation.

**Future directions:**
The study has been designed to allow future re-sampling of quadrats and for development of additional projects exploring potential interactions between *P. cinnamomi*, fire and climate change.

The plant functional trait work could be further enhanced through quantitative testing of the deduced changes in ecosystem function. This would determine the accuracy of plant trait methods for assessing ecosystem function changes in this and other WA vegetation types.

**Anticipated outcomes and management implications:**
- Identification of change by disease beyond species-level changes within the context of current ecological theories.
- Establishment of transects for future re-measure (to explore disturbance interactions).