University Grants 2010

The Wildlife Preservation Society of Australia University Research Grants are scholarships offered to honours or postgraduate students at Australian universities.

Each year, ten grants of $1,000 are awarded. The following articles are contributed by the 2010 winners.

Down but not out:

Spatial and temporal variation in declining eastern quoll (*Dasyurus viverrinus*) populations in Tasmania

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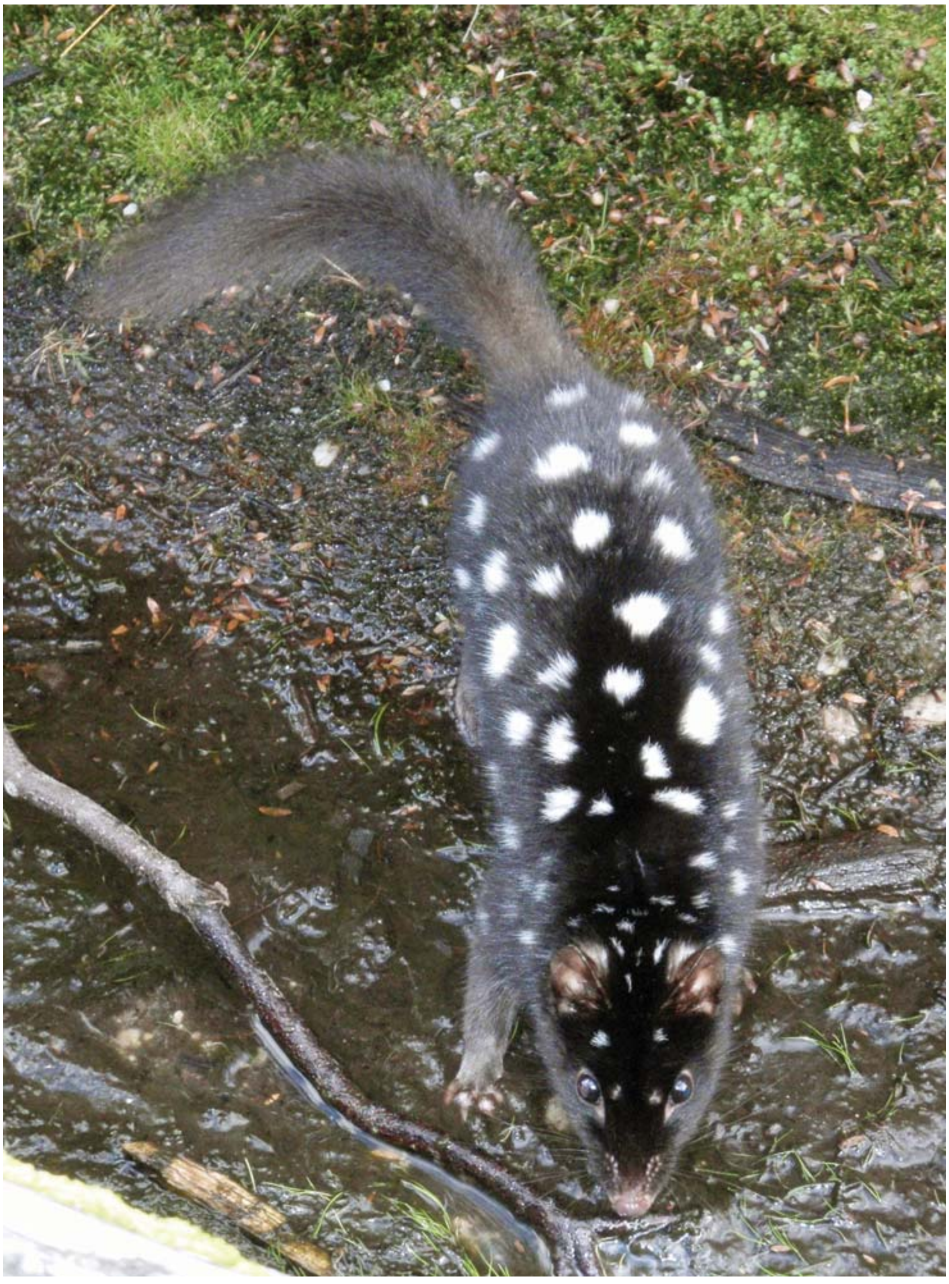
The eastern quoll is a small carnivorous marsupial that plays an important ecological role in reducing carrion and controlling pasture grubs throughout much of agricultural Tasmania. It is considered extinct on the Australian mainland, with its demise primarily attributed to predation by foxes (*Vulpes vulpes*), although disease has also been implicated. Tasmania now represents the species' last remaining stronghold, but whilst still considered widespread and common throughout Tasmania, the eastern quoll is facing a rapid decline in numbers. Recent spotlighting trends suggest declines of over fifty percent statewide over the past ten years, with some areas showing more marked declines than others. If these spotlighting surveys accurately reflect changes in wild eastern quoll populations, then such a reduction meets the IUCN criteria for listing the species as endangered.



A black eastern quoll at Cradle Mountain

Reasons for the rapid rate of attrition are not currently understood and as such, no appropriate management plan exists for the ongoing monitoring, management and conservation of the species, nor the mitigation of key threats responsible for its decline. In the absence of any definitive cause and with the recent introduction of foxes into Tasmania, the eastern quoll may be facing a very real threat of extinction.

This research is a critical step in filling current knowledge gaps surrounding the current status of the eastern quoll across Tasmania and in identifying responsible agents of decline and associated stressors. The objectives of the project are two-fold:

- To establish relative abundance of the eastern quoll at a number of sites across Tasmania and compare results to historic data in order to confirm whether populations are declining, as suggested by annual spotlighting surveys; and
- To assess wild eastern quolls for any apparent causal factors that may be contributing to their decline (eg body and health condition, reproductive output,

Image above: Bronwyn Fancourt with a Tasmanian devil captured as part of the eastern quoll surveys dietary analysis, population demographics, etc).

I have collected mark–recapture data through live trapping of eastern quolls at three study sites around Tasmania during March, May and July. Each of these sites was historically considered an eastern quoll ‘hotspot’, however, my preliminary results from all three sites appear to support the declining trends identified in the spotlighting data.

The next logical question is ‘why?’ Numerous samples have been collected from captured individuals to help in analysing possible causative factors. Analysis of morphometric data, blood samples, scats and population structure is currently underway to try to identify if health condition, reproductive output, diet or broader ecological factors may be indicative of any potential agents of decline or associated stressors. Whilst the list of potential agents of decline is almost endless, this analysis will help identify which areas warrant more detailed testing and those that should be considered priorities in future research.

A tan eastern quoll on Bruny Island

I would like to thank the Wildlife Preservation Society of Australia for their financial support, which has contributed to the crucial fieldwork component of this research. I would also like to acknowledge the provision of additional financial and in-kind support from: Holsworth Wildlife Research Trust, Royal Zoological Society of NSW, M.A. Ingram Trust, Save the Tasmanian Devil Program and the University of Tasmania.

Eastern quoll pouch young

Australia's freshwater biodiversity:

Decision making for conserving Australia's freshwater biodiversity under climate change and land-use change

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Much of Queensland's natural environment is climate-sensitive and at risk of a potential decline in biodiversity due to climate change impacts such as increasing temperatures, more severe droughts, riverine flooding, storm tides and sea-level rise. When combined with other threats, such as land clearing, urbanisation and changes in hydrology, there is growing evidence to suggest that climate change will negatively interact with other stressors and synergistically contribute to the degradation of freshwater biological diversity at the species, genetic and habitat level.

The main aim of my project is to gain an understanding of the combined effects of climate change, habitat loss and other drivers of land-use change on freshwater ecosystems. Then, to develop a framework and recommendations for making robust decisions to conserve biodiversity in the face of both climate and land-use change. This research will combine decision analysis with quantitative ecological models to identify priority actions to conserve freshwater biodiversity threatened by climate and land-use change in Queensland. This will address critical questions arising in the development of policy for climate change adaptation, especially in respect to maintaining environmental values and ecosystem function.

My PhD project will make a significant contribution to Queensland's capacity for improved decision making for climate adaptation and enhance our understanding of the combined effects of climate change and land-use change on freshwater ecosystems. In Queensland our ecosystems are some of the most biodiverse areas on the planet. For example, the Wet Tropics represent one of the richest biodiversity hotspots: around 42% of Australia's native freshwater fish species, 58 waterbird, 42 frog and 152 aquatic plant species, and many of these are found nowhere else in the world. A new Decision-Analysis Framework and a Decision Model for freshwater biodiversity conservation in Queensland will be developed and tested. This will lead to improved adaptation options to ensure freshwater biodiversity resilience; and a shared understanding how to incorporate climate change adaptation measures into routine conservation strategies and natural resource management.

Spangled perch (*Leiopotherapon unicolor*)

Crimsonspotted rainbow fish (*Melanotaenia duboulayi*)

South east Queensland freshwater ecosystem

Freshwater turtles, dispersal, and river damming:

Using genetics to investigate likely long-term impacts of river damming on ecologically diverse freshwater turtles

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Human-induced changes to river systems (eg damming, water extraction for irrigation) severely impact sensitive freshwater organisms through processes such as habitat loss and fragmentation. My PhD research focuses on a neglected but important group, freshwater turtles. Australia supports a distinctive and ecologically diverse turtle fauna. However, these key components of freshwater ecosystems are very poorly researched. In particular, very little is known about the dispersal patterns and population genetics of most species.

Dispersal among small local populations is important for species survival. It connects populations across the landscape, preventing inbreeding and allowing recovery from local extinctions. However, the extent to which impoundments present barriers to dispersal in highly aquatic turtles is largely unknown, making it difficult to assess the likely long-term impacts of reduced dispersal on population connectivity and persistence. Some river turtles may also be more vulnerable than others due to their specific habitat requirements and assumed reduced dispersal capacity.

Common Krefft's river turtles waiting for release back into the Fitzroy River

My research aims to establish the important link between habitat specialisation, dispersal ability and population connectivity, in order to assess likely long-term impacts of river regulation on ecologically different river turtles. Specifically, I'm using genetic techniques to compare patterns of genetic diversity and population connectivity (gene flow) between at least two very different species of turtle. Krefft's turtle (*Emydura macquarii krefftii*) has broad habitat requirements and is common and widespread in Queensland. By contrast, the white-throated snapping turtle (*Elseya albagula*) is a threatened ecological specialist unique to the Fitzroy, Burnett and Mary River drainages of central and south-east Queensland. As the project progresses, I also hope to include other turtle species, such as the little-known Irwin's turtle (*Elseya irwini*) identified from only a few sites within the Burdekin River system of north Queensland.

The most enjoyable part of my research is field work. I have already travelled to many interesting sites throughout Queensland to catch turtles, by boat or snorkel or using nets and traps. Turtles are measured and tagged, and a small sample of skin is taken from each animal to provide DNA for genetic analyses. To date, I have collected genetic samples from over 130 turtles

Image Above: Erica Todd working in the genetic's lab.

from five separate species. Other Australian turtle researchers have kindly supplied many more samples for my project.

This research will be the first detailed comparative genetic study of ecologically important river turtles in Queensland, and the first of its kind to assess long-term genetic implications of dams and weirs for this group. It will have important conservation outcomes, providing invaluable information for species management programs and for prioritising conservation actions. By addressing a prominent research gap in Australian freshwater turtle biology, I hope that a better understanding of the vulnerability of different freshwater turtle species to habitat fragmentation will assist conservation planners to design more effective management strategies.

The beautiful Fitzroy River

A juvenile white-throated snapping turtle

The role of cracking clay soils in maintaining fauna and flora biodiversity in the arid rangelands of South Australia

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University of South Australia.
Sophie (Topa) Petit (Academic Supervisor)

I am investigating the dynamics of biodiversity in cracking clay soils of the arid rangelands. In particular, I am trying to determine why these soils are important for biodiversity and how their associated wildlife is affected by cattle grazing. Grazing is the dominant industry in the rangelands and it is expected that this research will assist in refining our knowledge of the interactions between stock, the landscape, and wildlife. The main aims of the project are to examine the shelter properties of cracks (especially their role in temperature and humidity control), determine the effects of grazing on flora and fauna biodiversity at several study sites, appraise the role of cracking clay soils in arid-zone food webs, elucidate how cracking clays are used spatially and temporally by small arid-zone fauna, and develop recommendations for the management of areas characterised by cracking clays.

Much of my time is spent at six study sites, located on a cattle lease approximately 180 kilometres south-east of Coober Pedy in arid South Australia. Vertebrate and invertebrate trapping (with pitfall and Elliott traps) began in April 2009. When captured, a number of measurements relating to condition are recorded for vertebrates, while invertebrates are collected for later identification and biomass analyses. I also collect vertebrate scats for dietary analysis and determination of food webs. The temperature and humidity of cracks are examined with data loggers, in summer and winter. Certain vertebrate species are radio tracked in order to understand how they use cracking clay habitats.

Woomera slider (*Lerista elongata*)

Cracking clay soils support a range of mammal and reptile species at my study sites, including plains rats (*Pseudomys australis*), fat-tailed and stripe-faced dunnarts (*Sminthopsis crassicaudata* and *S. macroura*), Forrest's mice (*Leggadina forresti*), Giles' planigales (*Planigale gilesi*), gibber dragons (*Ctenophorous gibba*), Eyrean earless dragons (*Tympanocryptis tetraporophora*), and Woomera sliders (*Lerista elongata*), to name a few. Many of these species choose cracks as shelter when they are released. Preliminary radio tracking data suggest that dunnarts use cracks as resting sites during the day. Interestingly, the cracks provide a relatively stable microclimate, showing minimal fluctuations in temperature and humidity compared to conditions outside of cracks. In summer, these cracks may exhibit temperatures several degrees cooler than those outside, while in winter the cracks are warmer than prevailing outside temperatures. Several field trips are left; I expect that the research will be completed during 2011.

I feel privileged to have been given the opportunity to conduct research in the arid zone. It has rekindled many memories from my childhood spent on a cattle station in central Australia and reintroduced me to the enigmatic and fascinating wildlife of the Australian desert. I am extremely grateful to the Wildlife Preservation Society of Australia for supporting my research, both in 2010 and in 2008.

Image above: Helen Waudby releasing a reptile

Bat succession in restored bauxite minesites of the jarrah forest

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South-west Australia is one of the world's 25 biodiversity hotspots; this region holds exceptional concentrations of endemic species that are facing extreme losses of habitat. For example, this area is home to two species of bats, western false pipistrelle (*Falsistrellus mckenziei*) and western long-eared bat (*Nyctophilus major*), that are found nowhere else, other than one isolated western long-eared bat population in the Nullabor Plain. The native jarrah forest (*Eucalyptus marginata*), located within the Darling Range east of Perth, is included in this biodiversity hotspot. Alcoa of Australia Limited (hereafter Alcoa) holds a mining lease encompassing almost all of the northern jarrah forest, clearing and mining over 500 hectares annually. Alcoa is committed to restoration with the goal of establishing a self-sustaining jarrah forest. A considerable investment of work has been dedicated to evaluating this restoration goal in terms of vegetation, but much less research has focused on the ability of wildlife to recolonise these restored bauxite minesites.

In total, nine species of forest-dwelling insectivorous bats inhabit the native jarrah forest of south-western Australia. Bats are often considered to be resilient to human disturbances as they are highly mobile, roost in man-made structures and have a diverse diet. However, bauxite mining tests this resilience with the complete clearing of over-mature, senescent trees that house hollows suitable for bat shelter and breeding. Hollow-formation can take over a century to develop and the rate of loss of hollow-bearing trees will undoubtedly exceed replacement within a bauxite mined landscape. A rough calculation derived from studies on bat roost requirements and hollow formation in jarrah and marri (*Corymbia calophylla*) trees suggests that one hectare of average stand structure jarrah forest yields approximately 28 hollows suitable for tree-dwelling bats. As bats preferentially choose hollows, a conservative measure may be a rate of 5,000 to 10,000 roosts lost per year in the northern jarrah forest due to bauxite mining. Of course, trees naturally die and fall in a normally functioning ecosystem but bauxite mining both accelerates and concentrates this loss.

Artificial tree hollows, or bat boxes, are one interim solution. An extension of my PhD research will be to place bat boxes within restored minesites, testing a variety of designs, to determine their potential as a means of ameliorating the impact of bauxite mining on jarrah forest bats. The funding provided from the Wildlife Preservation Society of Australia is instrumental as it has enabled me to purchase 12 bat boxes, which will be placed in the jarrah forest in October and monitored fortnightly over the next three years. The findings from my research will be provided to Alcoa to incorporate into future land management decisions that best conserve bat populations in the northern jarrah forest.

Lesser long-eared bat (*Nyctophilus geoffroyi*)

Joanna working in the field

Planting a resilience movement:

Best-practice approaches for restoring Murray-Darling ecosystems that are resilient to climate change

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Australian Centre for Evolutionary Biology and Biodiversity,
and the School of Earth and Environmental Science,
The University of Adelaide

Habitat restoration is critical for ameliorating the ecological impacts associated with climate change. Existing restoration practices are generally based on *ad hoc* 'rules-of-thumb', lacking a firm scientific basis and failing to account for future climates. This risks wasting limited resources and producing sub-optimal long-term outcomes. We propose to build on current seed sourcing and restoration techniques, so that revegetation practitioners and community groups can make science-based decisions when planning revegetation projects.

We will focus on large-scale revegetation projects in the Murray-Darling Basin (MDB), using three native, keystone revegetation species, *Eucalyptus socialis, E. gracilis* and *E. incrassata*, as our focal species. We aim to investigate (1) the synergistic effects of plant isolation due to habitat clearing and local adaptation on the genetic 'quality' of seeds, (2) the genetic connectivity of trees and populations of trees across the MDB and (3) the tree mating patterns in both intact and isolated contexts. This information will provide very useful practical knowledge about potential alternative provenancing combinations for revegetation scientists, managers and community groups.

From May to July 2010 over 2,500 seedlings were planted at three sites across the MDB for experimental growth trials. The northern site is Scotia Sanctuary (Australian Wildlife Conservancy), the middle site is Yookamurra Sanctuary (Australian Wildlife Conservancy) and the southern site is Monarto Woodland (Forestry South Australia). Each seedling was measured and had a leaf sample collected for DNA extraction prior to planting. Seedling establishment and performance will be monitored for at least the next two years to assess the genetic 'quality' of seeds. The upcoming spring and summer period will involve genetic work to determine mating patterns and genetic connectivity across the MDB for the target species. Over thirty dedicated volunteers of all ages, backgrounds and interests have helped make this enormous task a success thus far and we hope many more will contribute in the future.

The core of this project is funded by a Native Vegetation Council of South Australia research grant, and the financial support of the WPSA is greatly appreciated – thank you!

Eucalyptus gracilis seedling just after planting at Yookamurra Sanctuary

Pollination in action: this large butterfly, a spotted Jezabell (Delias aganippe), was one of many seen sipping the nectar in a stand of flowering Eucalyptus gracilis in July 2010, north-eastern Dengali Conservation Park, SA. Pollination is an important factor in determination of seed genetic 'quality' and pollination is likely affected by climate change and habitat fragmentation. All Photos: M Breed

Eucalyptus incrassata seedlings looking healthy at Mt Lofty Botanic Gardens Nursery

A snappy bit of research:

Assessing the level of impact of cane toads on Australian freshwater crocodiles

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Interactions between predators and prey are the major drivers of the dynamics of populations, communities and ecosystems. When either the prey or the predator becomes an invasive species, it has the potential to alter natural ecosystems by different pathways, such as predation, competition, disease transmission or indirect negative effects on food webs. While much research has been focused on understanding how native prey adapt to exotic predators, the opposite issue – responses of native predators to exotic prey – is less well understood.

The cane toad (*Bufo marinus*= *Rhinella marina* under the current taxonomy), a large invasive toxic amphibian, has expanded its range through more than one million km^2 of Australia since its introduction to Queensland in 1935. The defensive toxins of these toads (toxins of the bufadienalides group) are very different to those found in Australian native frogs. Because Australia has no native toads, many Australian predators, including freshwater crocodiles (*Crocodylus johnstoni*), do not have resistance to these naïve toxins, and die from eating the toads. Intriguingly, the population-level impact caused by toads on freshwater crocodiles shows great spatial heterogeneity, ranging from no discernible impact in certain water bodies to massive population reductions in other areas (for example 77 percent population decline in certain water holes at Victoria River after toads arrived).

Currently, we do not know the magnitude of the population declines in crocodiles for most locations, and we do not know how long it will take for populations to recover following toad invasion. Potentially, populations could recover slowly (over many generations) or quickly, by selection for changes in feeding behaviour or toxin resistance. One part of my PhD seeks to examine whether different populations of

Australian freshwater crocodile

crocodiles throughout their range (Queensland, Northern Territory and Western Australia) have different levels of resistance to cane toad toxins. I am measuring the resistance of individual crocodiles to toad toxin by using the decrement in swimming speed following a dose of toxin (the chemical by the trade name Bufalin, which is very similar to toad toxins). In another set of experiments I am assessing the feeding responses of hatchling crocodiles towards toads and native frogs and testing whether crocodiles possess innate learning abilities to avoid certain tastes (thus learn to avoid cane toads). Results from these experiments along with my ongoing field-based studies (toad–crocodile encounter rates, crocodile population structure over time, stomach content analysis etc.) will allow me to determine whether freshwater crocodiles show adaptive changes in response to cane toads, and if so, how long it takes for such changes to occur once an area is colonised by cane toads. This information is crucial for predicting the longer term impact of toads on freshwater crocodiles, identifying which geographic populations are most at risk from toads, and allowing effective management plans to be formulated.

Hatchlings about to be swimming in a heated pool in the laboratory

Sub-adult crocodile grabbing a large female cane toad

Ecoenergetics of the western swamp tortoise:

Modelling the translocation viability of Australia's rarest reptile

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It is now widely accepted that many parts of Australia will undergo relatively rapid changes in climate. In the past, species could move into neighbouring habitats as environmental conditions changed. But now, habitat destruction and fragmentation will prevent many species from dispersing into areas capable of supporting them in the long term. As Australia already has the worst rate of mammal extinction in the world, and has an ongoing history of rapid habitat alteration, it is likely to become a hotspot for species extinctions unless new solutions can be discovered to mitigate the effects of environmental change.

One promising, but controversial, solution to protect vulnerable species is to physically translocate them into climatically suitable areas – a process termed 'assisted migration'. This process has been identified as being a potential management option for Australia's rarest reptile – the western swamp tortoise (*Pseudemydura umbrina*). The western swamp tortoise was thought to be extinct until it was rediscovered in 1953. A single breeding population of less than 100 individuals now occupies an ephemeral swamp on the outskirts of Perth, Western Australia, and three non-breeding populations exist on reserves to the north into which individuals bred in captivity at Perth Zoo are being introduced. Despite intense conservation efforts, population establishment has been hindered because of a shifting climate. In particular, a decreasing trend in winter rainfall has resulted in the swamp habitat becoming increasingly marginal, and constant pumping of bore water has been necessary to maintain water levels at one site since 2003. Current conservation practices have demonstrated that captive-bred tortoises can be successfully introduced into the wild, but translocation sites that can offer good habitat under future climates are urgently required to ensure the long-term survival of the species.

My research aims to address how we can pinpoint the sites where threatened species are most likely to survive under future climates, by modelling the energy balance of the western swamp tortoise under current and future climates. I am collaborating with staff at Perth Zoo and the Department of Environment and Conservation in project SWAMPI – the South West Assisted Migration for endangered Populations Initiative. I will measure the effects of temperature and food availability on the metabolic rates, growth rates, digestive physiology and behaviour of *P. umbrina*. The biophysiological data I collect will be integrated with an independent model of their wetland habitat, and the resulting mechanistic model will be used to predict tortoise survival, growth and reproduction under different climate scenarios. These models will allow me to predict which wetlands will allow tortoises to survive and reproduce under hotter, drier climates. While decision-making frameworks can be constructed to assess the potential biological and socio-economic costs of assisted migrations, high resolution models that are capable of predicting species survival under future climates will be critical in increasing the success of translocation programs in the future.

A western swamp tortoise fitted with a radio-tracking device. Photo courtesy of Gerald Kuchling

A captive-bred tortoise being released by Sophie Arnall

Declining *Eucalyptus wandoo* woodlands:

What habitat characteristics impact wildlife?

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Since the 1980s, *Eucalyptus wandoo* have been experiencing a decline across their range from their higher rainfall locale in the Perth Hills to the drier woodlands of the wheatbelt. To date a number of studies have been instigated to examine the possible causes of the decline. However, no studies have examined the possible impact of the decline on fauna. Loss of *E. wandoo* trees or even stands can reduce habitat quality and alter habitat characteristics such as leaf litter, understorey density and canopy cover which provide foraging and shelter resources for fauna. On a broad scale this study aims to determine how the changes in habitat characteristics due to declining tree health impact on small mammals, reptiles, amphibians and birds in the *E. wandoo* woodlands. One area of research is how tree decline alters flowering phenology and productivity of *E. wandoo,* and in turn, what impact this will have on the wildlife that rely upon nectar and flowering events for food resources.

Seed traps have been installed underneath 24 *E. wandoo* trees in different states of health to collect fruit, seeds, buds, flowers and opercula. This will allow the determination of flower (therefore, pollen and nectar) resources, and fruit resources available from healthy or declining *E. wandoo* trees. Canopy seed stores of *E. wandoo* are additionally being monitored at monthly intervals.

Bird surveys investigating the direct impacts of *E. wandoo* crown decline on their foraging resources are underway.

Western pygmy possum (*Cercartetus concinnus*)

Western pygmy possum (*Cercartetus concinnus*)

Foraging rates determined by bird observations indicate the differences in foraging resources (including pollen and nectar resources revealed by the seed traps) between healthy and declining *Eucalyptus wandoo* trees.

Future work in 2011 will include radio tracking of *Cercartetus concinnus* (western pygmy possum) to determine the impact of tree decline on their nesting and foraging sites. To date, 25 individuals (from over 16 trap nights) have been captured, with the majority found in healthy sites. In addition to tracking, the flowering phenology data will reveal what pollen and nectar resources are available to *C. concinnus*. Little is known about the biology of these small nectarivores and their mysterious lifestyle. This study hopes to investigate what nesting and foraging resources these tiny animals are using to determine whether the decline of *E. wandoo* tree health is likely to negatively impact their biology.

From this work we will hopefully have a better understanding of the impact of tree decline on woodland wildlife and how it can be better managed.