

1 Research Reports – 2006

Sustainable tourism in arid Australia: the behaviour and impact of nature tourists on vegetation and selected wildlife species.

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Park management is usually confronted with the daunting task to conserve resources and to simultaneously provide a satisfying tourism experience – two goals that can be conflicting or even mutually exclusive. Thus we will conduct an experiment at Fowlers Gap which aims to show that tourism products, in particular a sustainable form of nocturnal wildlife observation, can be designed to achieve a rich fauna-viewing experience for tourists with minimal impact on wildlife. We will compare different methods of nocturnal observation for their potential to satisfy tourism expectations and to minimize the impact on wildlife.

Nocturnal observation of wildlife has become a highly popular tourism attraction in many different ecosystems, worldwide. Since a lot of animals in Australia are nocturnal, night-time observation is commonly offered by many tour operators. During an internet search, we have identified at least 50 Australian businesses that explicitly advertise nocturnal observation as part of their wildlife tours. A study by the CRC for Sustainable Tourism revealed that 66 % of the 484 Australian businesses or organisations providing free-ranging terrestrial non-consumptive tourism activities continued their wildlife observations into the night. From the tourist point of view, night-time observation can be rewarding, with a sense of adventure into a realm people do not typically inhabit and the opportunity to view species and behaviour of wildlife not normally encountered during the day.

White light from torches or spotlights is the most common aid in nocturnal observation of wildlife. Some tourism operators use red light filters as it is assumed that nocturnal animals tolerate red light better than white light. Despite the increasing popularity of nocturnal observation, very little research exists about the impact of artificial night lighting on wildlife, even though it is likely to be quite significant. For instance, night active species like the Red Kangaroo or the Euro have a well developed olfactory receptor system, sensitive hearing and acute night sight and are therefore likely to be highly reactive to such stimuli. There is a small body of research on light pollution and its effects on wildlife as well as some studies that focus primarily on the physiological base of night vision in animals. Apart from a few early studies, that are rather anecdotal in nature, Wilson's study (1999) seems to be the only manipulative field experiment on the effects of nocturnal observations with spotlights (white or red light) on wildlife. During night observations with spotlights, possums appeared to be more stressed when exposed to higher intensity white light or even evaded the experimental area entirely. Furthermore, there seem to be no scientific studies that have investigated if red light does cause less stress for wildlife, except for Wilson (1999) who could not detect a significant stress relief for the possums when using red filters.

A few tour operators have recently started to enhance their night-time tours with more advanced forms of night-vision technology like light-amplifying night vision goggles, originally used by the military or special interest groups like hunters and researchers. Research undertaken for the improvement of recreational activities with wildlife should consider both, impact minimization for wildlife and maximum visitor satisfaction. The use of night vision equipment has the potential to achieve both, and should therefore be explored. There are various other factors, however, which also need to be taken into consideration like the time of the night and the location in which tours are conducted as well as environmental conditions like ambient wind

speed. All of these factors can potentially modify the level of visitor satisfaction that is achieved and the impact on wildlife.

The study will commence in early 2007 to compare the effects of the following factors:

1. 'Light Mode': To compare nocturnal observations with night vision goggles (2nd generation) and spotlights with white or red light for their impact on wildlife and their potential to achieve visitor satisfaction. The choice of night vision equipment will influence the species richness and total abundance of wildlife, the species richness and total number of bat passes (see 6.3), the percentage of bat feeding buzzes (see 6.3) as well as the overall wildlife or bat community and certain species in particular. The observation distance will be less with goggles than with white or red light. The proportion of animals exhibiting alert behaviour towards the observer relative to other behaviour (e.g. body maintenance) will be less with night vision goggles than with white or red light.
2. 'Observation Timing': To compare nocturnal observations early at night (1.5 hours starting after dusk) with observations later at night (1.5 hours starting 2 hours after dusk) for their impact on wildlife and their potential to achieve visitor satisfaction. Observation timing will influence the species richness and total abundance of wildlife, the species richness and total number of bat passes, the percentage of bat feeding buzzes, the observation distance and the wildlife community as a whole and certain species in particular.
3. 'Watch Mode': To compare stationary nocturnal observations at water tanks with ambulatory nocturnal observations in streambeds for their impact on wildlife and their potential to achieve visitor satisfaction. The species richness and total abundance of wildlife, the species richness and total number of bat passes, the percentage of bat feeding buzzes, the observation distance as well as the overall wildlife or bat community and certain species in particular will differ between observations conducted at water tanks and observations in streambeds. The proportion of animals exhibiting alert behaviour towards the observer relative to other behaviour (e.g. body maintenance) will be higher with ambulatory observations in streambeds.
4. 'Wind speed': To identify the effect of ambient wind speed. The species richness and total abundance of wildlife, the species richness and total number of bat passes and bat feeding buzzes will be less in windy nights.

The effects of water body size and distance from water on avian abundance and diversity.

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This study has examined the effects of the size of a water body from a water hole in Fowlers Creek through to the large open water body of Frieslich Dam on avian diversity and abundance. The avifauna at the water bodies was assessed through drought conditions as the surface area subsided. Transects from natural and artificial water bodies were also traversed through the hinterland to determine how the water body contributes to avifaunal abundance and diversity and to estimate the least water-dependent species. The results are currently being written up as a Diploma thesis.

Behaviour and ecology of the zebra finch

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We continued our ongoing research into the reproductive behavioural ecology of the zebra finch (*Taeniopygia guttata*), a classic nomadic arid zone specialist. The breeding season of 2006 was our third at Fowlers Gap and saw lower numbers of zebra finches in the area and fewer reproductive attempts, almost certainly due to the continuing drought conditions. This year was the first year of Mylene Mariette's PhD research that will be based on the study of this population and seeks to understand the evolution of coloniality in this species. Compared with over 300 pairs attempting to breed in the artificial nest boxes based in four areas in 2005 (Saloon, East and West Mandleman and Gap Hills), between September and December 2006 we had fewer than 100 pairs attempting to breed. The low number did allow us to conduct more intensive behavioural work on each pair. Using PIT tags to monitor the visits that each parent made to the nest we recorded detailed parental care observations for 34 nests for continual periods of between 24 hours and 10 days. Briefly, we found that the male and female visit the nest at the same time (in over 90% of cases) and that the overall number of visits per day was incredibly low (between 7 and 10 in any daylight period). We are currently analysing this data in detail and the corresponding growth rate of chicks (measured daily). These findings will be of great interest to the field because they are very unusual for birds generally and also will provide an interesting contrast with data gathered by those in Europe and North America who have conducted similar work on captive populations of zebra finch whose parental behavioural is very different and presumably quite unnatural.

Sex allocation in chestnut-crowned babbler

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Life-history theory suggests that females should differentially allocate resources to the sex which gives the greatest fitness returns. In cooperatively breeding birds, this is likely to be the male, since philopatric males are more likely to help in rearing subsequent offspring, while dispersive females are not. In chestnut-crowned babblers at Fowlers Gap, male offspring are far more likely to remain on their natal territory and help their mother to rear subsequent offspring than females. We predicted that mothers in small groups are more likely to lay more male eggs while females in large groups should be lay eggs closer to equity in sex ratio. Chestnut-crowned babblers are characterised by a plural cooperative breeding systems, in which up to two females may lay eggs in separate nests within a territory. Dominant females have the majority of helpers (3-13) while subordinate females typically have none or only a few helpers (0-3). Both subordinate and dominant females lay clutches of 4 eggs. However, we found that subordinate females laid clutches of eggs which were heavily (75%) biased towards males, while dominant females laid clutches that were 50% male. These skews in sex-ratio are among the greatest detected in avian cooperative breeding and lend significant support to the idea that females are able to facultatively adjust the sex of their offspring for their own benefit.

Benefits of cooperation in chestnut-crowned babbler

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Chestnut-crowned babblers (*Pomatostomus ruficeps*) are 50g cooperative breeding birds common in the arid zones of central eastern Australia. They are one of four members of the Pomatostomidae babblers in Australia, and the only one which remains to be studied. We have investigated the cooperative behaviour of up to 70 breeding groups of chestnut-crowned babblers at Fowlers Gap over the last three years. In 2004 and 2005, rainfall was average around 200mm, but in 2006, it was half this at 100mm. Breeding started in mid-July in all three years, but stopped in October in 2006 compared with December in the other two years. This is mainly because few groups had second breeding attempts in 2006, while around 50% did so in the other two years. Group sizes varied from 2 to 15 individuals in all three years, but helpers had different effects. In 2004/2005 helpers increased the number of breeding attempts the dominant pair were able to have in a breeding season, but had no effect on the number of offspring fledging per brood. In 2006, the reverse was true, helpers having a significant effect on chick survival within broods, but not affecting the number of broods had by the dominant pair. Finally, using a transponder system, we were able to measure the effect of helper number on the rate at which chicks were provisioned. We found that differences in breeding success between groups of different sizes are likely to be caused by differences in the rates in which chicks are fed, with chicks being fed substantially more often in large groups than in small groups.

Individual variation in cooperative behaviour in chestnut-crowned babblers

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Cooperatively breeding species, such as the chestnut-crowned babbler, are characterised by group members helping to raise young that are not their own. Such cooperative behaviour has been the subject of intensive study in a large number of bird and mammal systems, yet remarkably little is known about the significant variation often observed between members of the same group. We are trying to understand this variation using 70 groups of babblers in which all individuals are fitted with a uniquely coded transponder. During the incubation and nestling period of each group we are able to record the provisioning behaviour of group members that visit the nest using a remote data logging system that records the transponder ID of each bird. This will allow us to quantify the cooperative behaviour of different group members and to detect any individual differences in response to changes in nestling demand as the brood develops. In addition to the usual candidates for explaining variation in cooperative behaviour (condition, sex, age, breeding status and kinship to the recipients), we are investigating two likely causes that have previously been neglected: genetic differences and personality differences. Using cross-fostering techniques, in which chicks are reared in a group that is not their own, we will be able to disentangle the environmental versus genetic components of cooperative behaviour.

Recent work has found that individuals in a wide range of taxa show consistent behavioural differences, comparable to human personalities. We will use a battery of standardised

behavioural tests conducted in an aviary in order to identify the different personality types that exist in chestnut-crowned babblers. Evidence from other studies suggests that an individual's strategy for optimising its behaviour may be dependent on its personality type; hence the extent to which an individual cooperates in its group is likely to be determined, in part, by its personality.

Behaviour and ecology of the cooperatively breeding Apostlebird

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We have continued to develop this long-term study population of apostlebird (*Struthidea cinerea*) groups around Fowlers Gap. Our aim is to carry out detailed behavioural observations and experiments on various topics, such as foraging, vigilance, mobbing, vocalizations, allo-preening, allo-feeding and helping at the nest. We have therefore continued to catch, individually colour-band and bleed birds (for genetic analyses of relatedness), now totalling more than 220 individuals in over 20 social groups (representing approximately 2/3 of the birds in the study area), including all young produced during the 2006 breeding season. We have also succeeded in habituating 8 groups to the presence of human observers, with a further 5 being semi-habituated. For this we feed the birds small pieces of bread, first from feeders and then from the hand, with the ultimate aim of getting all individuals to regularly stand on electronic balances to assess individual changes in body mass. This year we continue to quantify nest site choice, group productivity and group home ranges during the breeding season. We also continued to develop methods of data collection and experimentation for projects into social foraging and cooperative anti-predator mobbing behaviour. The population of apostlebird groups at Fowlers Gap appears to be surprisingly fluid and rather flexible in breeding group formation and reproductive effort, as compared with populations further east in Australia. Birds often move between breeding groups, with larger winter groups splitting prior to breeding and then reforming into larger and more mobile groups when breeding is over. There are some interesting implications here for variable patterns of relatedness within and between groups, which will form the basis of our study of the mating system in this population.

Kangaroo management involving landholders in the Barrier Ranges

Investigators: Peter Ampt (FATE Program, UNSW), Alex Baumber (FATE Program, UNSW), Katrina Hannigan (FATE Program and Western CMA), with assistance from Western CMA, Department of Environment and Climate Change and landholders in the Barrier Area Rangecare Group (BARG).

This project is running over three years (July 2006-June 2009) with support from the Rural Industries Research and Development Corporation (RIRDC). The aim of the project is to explore ways in which landholders can collaborate on kangaroo management and in the process gain economic returns through participation in the commercial kangaroo industry, gain better strategic control of kangaroo grazing pressure and gain incentives to undertake conservation actions in line with the principles of conservation through sustainable use (CSU). Fowlers Gap has not had kangaroo harvesting for several decades and thus serves as a refuge within the cross-property

kangaroo management arrangements as well as a reference site for landscape monitoring using Landscape Function Analysis (LFA).

Fowlers Gap was used for meetings of landholders in August 2006 and May 2007 as well as for LFA training in March 2006 and November 2006. Fowlers Gap represents an important site for this training, as well as for a planned cross-property monitoring regime, due to the fact that it has several of the key landscape types present across the Barrier Area Rangecare Group (of which Fowlers Gap is a member), as well as records of past management and research actions (including exclusion of grazing). The main training round in November 2006 took place over two days and involved 10-15 landholders and natural resource managers.

The broader aims of the project were progressed over the past year through negotiations with the Department of Environment and Climate Change to develop an adaptive management trial proposed to commence in late 2007 or 2008. The trial would enable landholders to manage kangaroos as a common pool resource, through multi-property licensing, tagging and quota-setting arrangements. This trial will test whether 1) more flexible arrangements can lead to greater collaboration between landholders; 2) whether that collaboration can create opportunities for landholders to negotiate roles for themselves in the kangaroo industry that generate economic returns; 3) whether collaboration can allow better management of high-intensity kangaroo grazing events (through rapid and strategic response); and 4) whether returns from kangaroos can create incentives for conservation actions (such as setting aside areas for conservation or restoring native vegetation). Preliminary results indicate that economic opportunities exist through collective bargaining power and improving the reliability of kangaroo supply (and possibly quality) to processors.

ILIRI Report to Fowlers Gap 2006

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Funding

The COFA postgraduate student association received funding to construct a studio based on a similar design to the Ochre House. The site was selected along Homestead Creek towards the west of Solarch in July. The choice of building and colour of colorbond cladding was made and construction was anticipated but not realised in 2006. The project is under the management of Facilities.

Fowlers Gap Artists' Residencies

The ILIRI artists' residency program was formalised with considerable assistance from Peter Schell in consultation with COFA and the Risk Management Unit. Two programs have been established: 'The ILIRI Research Residency' and 'The ILIRI Artist Scholar Program'. The ILIRI Research Resident Program is open to artists who are UNSW academic staff and to artists with a record of high achievement and standing in the visual arts field. Artists must have a planned research project to enable them to work at Fowlers Gap. The ILIRI Artist Scholar Program is open to artists, post-graduate students and, in limited circumstances, to UNSW undergraduate studies in the visual arts field. Artists and students must have an approved artistic activity to enable them to work at Fowlers Gap.

A number of artists visited the Station in 2006 and amongst these were two ILIRI artists' residents:

Ben Beeton

Ben Beeton is young artist from Toowoomba who was sponsored by the Department of Environment and Conservation while in the Broken Hill region. Ben undertook a 3-week 'ILIRI Artist Scholar Program' based at the Ochre House. An exhibition of works including some from Fowlers Gap was held at the Broken Hill Regional Art Gallery in July 2006. A further exhibition was held in the Libby Edwards Galleries in Brisbane in April 2007. The artist's statement from that exhibition is as follows:

"If you want to make a new contribution, you've got to make a whole new preparation", Stephen R Covey

I am fascinated by the ancient past and how it relates to the present environment. My artistic practice draws its inspiration from a developing understanding of the natural environment and how it is connected to its evolutionary history. I aim to produce artworks that hold a balance between a subjective and objective appraisal of environments that I encounter.

As a practicing artist I now spend half the year at my home studio in Toowoomba and half the year travelling through remote locations in Australia. These trips often take the form of artist residencies. My new body of work features works from residencies in 2006 at Hill End, Bundanoon, Broken Hill and Fowlers Gap.

In a number of my most recent works I have developed an aesthetic that fuses painting, drawing and digital mediums. In order to develop a deeper understanding of the ecology, geology and natural history of the region I seek out the support of scientists.

The regions I have visited on residencies are well known for inspiring some of Australia's most famous artists such as Donald Friend, Arthur Boyd, Russell Drysdale, Pro Hart, John Olsen and Brett Whitely to name a few. Without exception I believe these artists have in their own way contributed to the visual mythology of Australia.

In visiting such artistically well represented regions of Australia I have chosen to look to science for answers to the notion of landscape. I believe that the myths that attach both indigenous and non-indigenous Australians to the land have been reinforced by artists. I further believe that these myths can be informed at a deeper level through the work of contemporary practitioners who inform themselves about Australia's natural history in order to incorporate this information into their artworks. In conjunction with these ideas is the notion that all elements of landscape are comprised purely of 'star dust'. By 'star dust' I mean elements that are neither born nor die, but merely change form in endless recombinations.

My next residency is at Clifton Pugh's property on the outskirts of Melbourne. After that I will travel to Spain to do a residency in the mountains outside of Barcelona with scientific consultation provided by the British Natural History Museum.

Gabrielle Courtenay

Gabrielle Courtenay is an artist of note and undertook a 1-month ILIRI Artist Scholar program at the Ochre House. She has subsequently had exhibitions in Melbourne and Sydney and submitted a work for the Wynne Prize. Her statement to ILIRI following her residency is as follows:

The month at Ochre House was an amazing experience personally and in my development as an artist. The full month with twenty one days of that in total isolation with no music, gave me time to totally absorb myself into the landscape, to shift consciousness and produce work and ideas that are not purely descriptive which I will be able to build on in my art practice.

The house is totally isolated and as an outsider from COFA I felt very removed from the main property at Fowlers Gap. I had spent considerable time in a small hut with no running water or electricity off a rough track years ago with small children so I was prepared for the isolation but the extreme heat, the constant bombardment of violent winds and the fragility of the satellite phones makes the isolation more extreme. This would not be different for someone staying two weeks or four as the elements are constant and you

need to adjust yourself to it.

My partner Gregory who drove from Sydney with me helped arrange the furniture around in the cabin so it could function better as an artist's studio. This was important as I spent each day working there from 9 - 5 p.m.. As the day gets very hot early, I rose at 6 am to do an hour of yoga and then an hour and a half of walking, observing and doing line drawings of the landscape. This was a very important part of absorbing myself into the landscape and becoming part of it, I then walked from 5 p.m. for another hour at least, looking sometimes drawing or painting, all the time watching the beauty of the land in the setting sun. By the end of the second week I found I had become more attuned to physicality of place around Ochre House and was able to spot the movements of animals and became very sensitive to detail in the land and in variety in the desert plants.

I had noticed on the drive to Fowlers Gap the reduced kangaroo and emu population from when I had visited that area many years ago and David Croft explained the dropping kangaroo numbers, this and the stark remains of the oasis that this property had been in the 1890's made me very conscious of the fragility of our land and it's destruction. The force and howling of the winds made me very conscious of global warming and I started to closely watch the salt bush which is made up of many plant lines holding itself together against the wind. As you get closer to the end of the hills and look out over the flat horizon of the desert like, sunken plains where the winds come in from the north east, I noticed that the salt bush all seem to be dying or dead and not regenerating. I collected samples of salt bush and did studies on black board of them which will be a new direction in my painting.

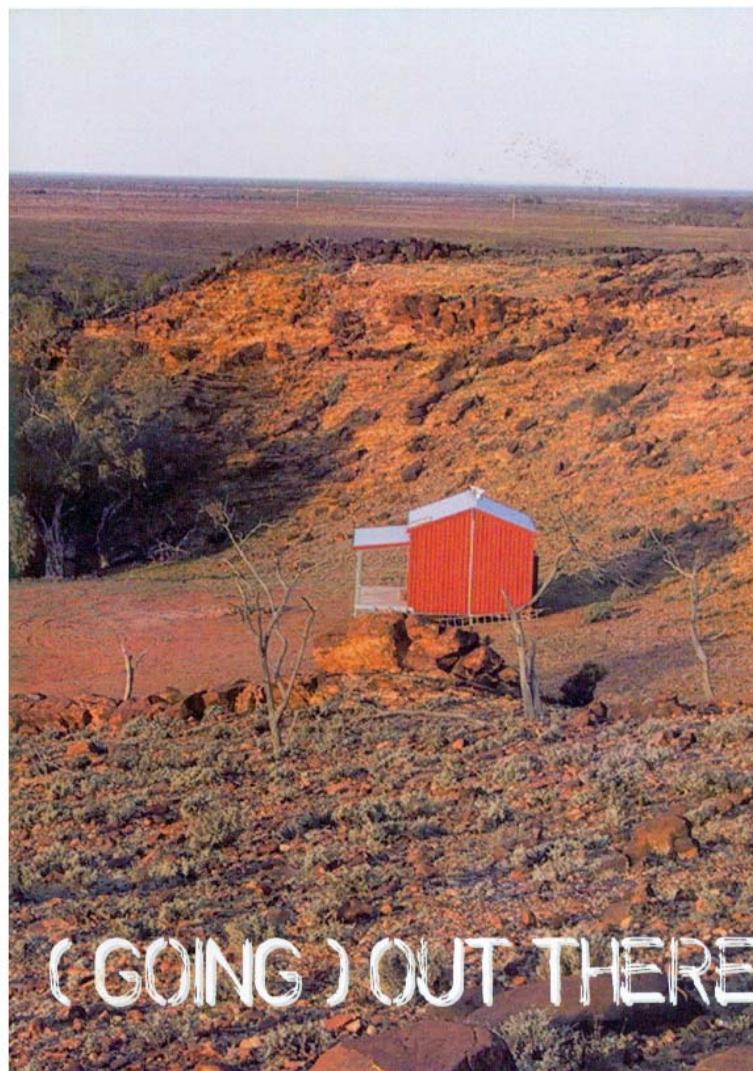
My time at Ochre House was extremely productive. I was determined not to rush into a pre existing language and did many drawing and small painting studies on canvas sheets before starting the three larger canvases and four smaller canvases as well as the 22 painted boards that I used for my salt bush studies. I spoke with David about the studio and I gave him suggestions to make the space work better for an artist to work in so I include these and some suggestions on making the communication better with Fowlers Gap.

I was lucky that I had a friend who is very generous, brought the Nissan Patrol that is used on his property for me to Sydney and gave it to me to use for the month as it would have been impossible for me to have paid the \$150 a day 4 WD hire fee as an artist especially when I am unable to generate any income. A 4 WD is an essential item to get into the gully where Ochre House is situated and I feel that the university needs to purchase a 4 WD that can be used for artists during their residency. It might be advisable as well that the resident should attend an advanced driving course as navigating into the property is not easy for those unfamiliar with country driving.

I would like to thank the Iliri Board for selecting me for the Residency as it was an incredible experience that I find is living very strongly in me. The residency has given me a greater awareness of our fragile environment, the sensitivity of the kangaroo, the zen beauty of the salt bush and the need to protect them for the future.

Research Activities

The association between ILIRI and Alliance Francaise led to a selection of work from '**Going Out There**' that was exhibited at the Alliance Francaise in Paris in early 2006. Idris Murphy and Louise Fowler-Smith travelled to France for the exhibition and met with representatives of French art bodies and schools to further the cause of European artists taking up residencies at Fowlers Gap through ILIRI.



Cover of exhibition catalogue

From the catalogue introduction:

“(Going) Out There shows the work of artists who have visited and experienced an area of land loosely bounded by Broken Hill, University of New South Wales Fowlers Gap research station, Lake Mungo and Mutawintji National Park. For most of these city-based artists this was their first experience of this site and this environment – and their first challenge to find adequate means of visual communication of their experience.

...“(Going) Out There is about these artists finding a means of responding to this new and strange environment – and their works are the material outcomes of their experience ‘out there’.”

Publications and theses 2000-2006

2000:

Croft DB (2000) Sustainable use of wildlife in western New South Wales: Possibilities and problems. *Rangeland Journal* **22**, 88-104.

Dawson TJ, Blaney CE, Munn AJ, Krockenberger AK, Maloney SK (2000) Thermoregulation by kangaroos from mesic and arid habitats: influence of temperature on routes of heat loss in grey kangaroos (*Macropus giganteus*) and red kangaroos (*Macropus rufus*). *Physiological and Biochemical Zoology* **73**, 374-381.

Dawson TJ, McTavish K, Munn A, Holloway JC, Ellis BA (2000) Red kangaroos and eastern grey kangaroos in the arid rangelands: factors impacting on water use. In 'Australian Rangeland Society Centenary Symposium'. Broken Hill. (Eds S Nicolson and J Noble). (Australian Rangeland Society)

Dawson TJ, Munn AJ, Blaney CE, Krockenberger A, Maloney SK (2000a) Ventilatory accommodation of oxygen demand and respiratory water loss in kangaroos from mesic and arid environments, the eastern grey kangaroo (*Macropus giganteus*) and the red kangaroo (*Macropus rufus*). *Physiological & Biochemical Zoology* **73**, 382-388.

Dawson TJ, Munn AJ, Blaney CE, Krockenberger AK, Maloney SK (2000b) Ventilatory accommodation of oxygen demand and respiratory water loss in kangaroos from mesic and arid environments, the eastern grey kangaroo (*Macropus giganteus*) and the red kangaroo (*Macropus rufus*). *Physiological And Biochemical Zoology* **73**, 382-388.

Dunkerley DL (2000a) Assessing the influence of shrubs and their interspaces on enhancing infiltration in an arid Australian shrubland. *The Rangeland Journal* **22**, 58-71.

Dunkerley DL (2000b) Flow hydraulics in laminar flows, the starting point for interrill sediment erosion and transport. In '9th Australian and New Zealand Geomorphology Conference'. Wanaka, New Zealand p. 25

Dunkerley DL (2000c) Water redistribution by runoff and runon in semi-arid mosaic landscapes – how does it work? In '9th Australian and New Zealand Geomorphology Conference'. Wanaka, New Zealand p. 26

Gibson DL (2000) Post-early cretaceous landform evolution along the western margin of the Bancannia Trough, western NSW. *The Rangeland Journal* **22**, 32-43.

Hewson RD, Taylor GR (2000) An investigation of the geological and geomorphological features of fowlers gap using thermal infrared, radar and airborne geophysical remote sensing techniques. *The Rangeland Journal* **22**, 105-123.

Holdaway SJ, Fanning PC, Witter D (2000) Prehistoric Aboriginal occupation of the rangelands: interpreting the surface archaeological record of far western New South Wales Australia. . *The Rangeland Journal* **22**, 44-57.

Lewis M (2000) Discrimination of arid vegetation composition with high resolution CASI imagery. *The Rangeland Journal* **22**, 141-167.

Macdonald BCT (2000) University of New South Wales Fowlers Gap Arid Zone Research Station - Nearly 50 years of research. *The Rangeland Journal* **22**, 5-31.

Macdonald BCT, Melville MD (2000) A comparison of the soils from two areas of sorted step chenopod patterned ground, at Fowlers Gap Field Station, western New South Wales. *The Rangeland Journal* **22**, 72-87.

Roach AME (2000) Review of the Australian species of the dermestid genus *Anthrenocerus* Arrow (Coleoptera: Dermestidae). . *Invertebrate Taxonomy* **14**, 175-224.

Tay WT, Crozier RH (2000a) Microsatellite analysis of gamergate relatedness of the queenless ponerine ant *Rhytidoponera* sp. 12. *Insect Societies* **47**, 188-192.

Tay WT, Crozier RH (2000b) Nestmate interactions and egg-laying behavior in the queenless ponerine ant *Rhytidoponera* sp. 12. *Insect Societies* **47**, 133-140.

2001:

Buffenstein S, McCarron HCK, Dawson TJ (2001) Erythrocyte osmotic fragility of red (*Macropus rufus*) and grey (*Macropus fuliginosus* and *Macropus giganteus*) kangaroos and free-ranging sheep of the arid regions of Australia. *Journal of Comparative Physiology B Biochemical Systemic and Environmental Physiology* **171**, 41-47.

Croft DB (2001) 'Rangeland Kangaroos; A world class wildlife experience. Wildlife Tourism Research Report Series: No 16.' Cooperative Research Centre for Sustainable Tourism, Gold Coast.

Croft DB, Leiper N (2001) 'Assessment of opportunities for international tourism based on wild kangaroos. Wildlife Tourism Research Report Series: N0. 17.' Cooperative Research Centre for Sustainable Tourism, Gold Coast.

Dunkerley DL (2001) Estimating the mean speed of laminar overland flow using dye injection -uncertainty on rough surfaces. *Earth Surface Processes and Landforms* **26**, 363-374.

Dunkerley DL, Domelow P, Tooth D (2001) Frictional retardation of laminar flow by plant litter and surface stones on dryland surfaces: a laboratory study. *Water Resources Research* **37**, 1417-1424.

Fanning PC, Holdaway SJ (2001a) Stone artefact scatters in western NSW, Australia: geomorphic controls on artifact size and distribution. *Geoarchaeology: an International Journal* **16**, 667-686.

Fanning PC, Holdaway SJ (2001b) Temporal Limits to The Archaeological Record in Arid Western NSW, Australia: Lessons from OSL And Radiocarbon Dating of Hearths and Sediments. In Jones, M. and Sheppard, P. (eds) *Australasian Connections and New Directions: Proceedings of the 7th Australasian Archaeometry Conference. Research in Anthropology and Linguistics* **5**, 91-111.

McCarron HCK, Buffenstein R, Fanning FD, Dawson TJ (2001) Free-ranging heart rate, body temperature and energy metabolism in eastern grey kangaroos (*Macropus giganteus*) and red kangaroos (*Macropus rufus*) in the arid regions of South East Australia. *Journal of Comparative Physiology B Biochemical Systemic & Environmental Physiology* **171**, 401-411.

Munn A, Dawson TJ (2001) Thermoregulation in juvenile red kangaroos (*Macropus rufus*) after pouch exit: higher metabolism and evaporative water requirements. *Physiological and Biochemical Zoology* **74**, 917-927.

Segheri J, Dunkerley DL (2001) Specific methods of study. In 'Banded vegetation patterning in arid and semiarid environments.' (Eds DJ Tongway, C Valentin and J Segheri) pp. 32-51. (Springer Verlag: New York)

Thiery J, Dunkerley DL, Orr B (2001) Landscape models for banded vegetation genesis. In 'Banded vegetation patterning in arid and semiarid environments.' (Eds DJ Tongway, C Valentin and J Segheri) pp. 167-197. (Springer Verlag: New York)

2002:

Dunkerley DL (2002a) Canopy interception losses in dryland plant communities: why are they important, and how can we measure them? In 'Tenth Conference of the Australian and New Zealand Geomorphology Group'. Kalgoorlie, Western Australia p. 17

Dunkerley DL (2002b) Infiltration rates and soil moisture in a groved mulga community near Alice Springs, arid central Australia: evidence for complex internal rainwater redistribution in a runoff-runon landscape. *Journal Of Arid Environments* **51**, 199-219.

Dunkerley DL (2002c) Measuring interception loss and canopy storage capacity in dryland vegetation: a brief review and evaluation of available research strategies. *Hydrological Processes* **14**, 669-678.

Dunkerley DL (2002d) Surface tension and friction coefficients in shallow, laminar overland flows through organic litter. *Earth Surface Processes and Landforms* **27**, 45.58.

Dunkerley DL (2002e) Volumetric displacement of flow depth by obstacles, and the determination of friction factors in shallow overland flows. *Earth Surface Processes and Landforms* **27**, 165-175.

Dunkerley DL, Brown KJ (2002) Oblique vegetation banding in the Australian arid zone: implications for theories of pattern evolution and maintenance. *Journal Of Arid Environments* **51**, 163-181.

Fanning PC (2002) Beyond the Divide: A New Geoarchaeology of Aboriginal Stone Artefact Scatters in Western NSW, Australia. PhD thesis, Macquarie University.

Fanning PC, Holdaway SJ (2002) Artefact Visibility at Open Sites in Western New South Wales, Australia. *Journal of Field Archaeology* **29**, 255-271.

Frank ASK (2002) Reptile diversity in different habitats in the Australian arid zone. Diploma thesis, Bonn University.

Holdaway SJ, Fanning PC, Witter D, Jones M, Nicholls G, Shiner J (2002) Variability in the chronology of late Holocene Aboriginal occupation on the arid margin of southeastern Australia. *Journal of Archaeological Science* **29**, 351-363.

Keating D (2002) Soil loss and soil processes at Fowlers Gap, western New South Wales. BSc. (Hons) thesis, Macquarie University.

Wilson S, Scott N, Croft DB (2002) Wild partnerships. *Animals Today* **10**, 12-14.

Witte I (2002) Spatio-temporal interactions of arid zone mammalian herbivores. PhD thesis, University of NSW.

2003:

Athey CA (2003) Reproductive strategies of male Euros (*Macropus robustus erubescens*) in north western New South Wales: Effects of prolonged low rainfall. PhD thesis, University of NSW.

Dawson TJ, Webster KN, Mifsud B, Raad E, Lee E, Needham AD (2003) Functional capacities of marsupial hearts: Size and mitochondrial parameters indicate higher aerobic capabilities than generally seen in placental mammals. *Journal of Comparative Physiology B Biochemical Systemic & Environmental Physiology* **173**, 583-590.

Dunkerley DL (2003a) Determining friction coefficients for interrill flows: the significance of flow filaments and backwater effects. *Earth Surface Processes and Landforms* **28**, 475-491.

Dunkerley DL (2003b) An optical tachometer for short-path measurement of flow speeds in shallow rill and interrill flows: improved alternative to dye timing. *Earth Surface Processes and Landforms* **28**, 777-786.

Dunkerley DL (2003c) Organic litter: dominance over stones as a source of interrill flow roughness on low-gradient desert slopes at Fowlers Gap, arid western NSW, Australia. *Earth Surface Processes and Landforms* **28**, 15-29.

Fisher AG (2003) The geomorphic evolution of Australia stony deserts : an application of in situ-produced cosmogenic radionuclide analysis at the Fowlers Gap arid zone research station. PhD thesis, University of New South Wales.

Hill SM, Roach IC (2003) The regolith-landforms of Sandstone Paddock, Fowlers Gap, western NSW. In 'Advances in Regolith'. (Ed. IC Roach) pp. 193-200. (Cooperative Research Centre for Landscape Evolution and Mining Engineering: Canberra)

Kloecker U (2003) An evaluation of factors leading to kangaroo-vehicle collisions in the arid zone of Australia. Diploma thesis, University of Bonn.

Munn A, Dawson TJ (2003a) Energy requirements of the red kangaroo (*Macropus rufus*): impacts of age, growth and body size in a large desert-dwelling herbivore. *Journal Of Comparative Physiology B Biochemical Systemic And Environmental Physiology* **173**, 575-582.

Munn AJ, Dawson TJ (2003b) How important is milk for near-weaned red kangaroos (*Macropus rufus*) fed different forages? *Journal Of Comparative Physiology B Biochemical Systemic And Environmental Physiology* **173**, 141-148.

Webb J (2003) The role of soil shrink-swell in the formation of patterned ground. In 'Advances in Regolith'. (Ed. IC Roach) pp. 432-436. (Cooperative Research Centre for Landscape Environments and Mineral Exploration: Canberra)

2004:

Baniandres N (2004) Effect of upbringing and experience on herbivore diet selection in the Australian arid rangelands: Comparison between red and western grey kangaroos. Graduate Diploma thesis, University of New South Wales.

Barry M (2004) Wildlife tourism in Australia: Testing two wildlife-viewing strategies on free-living kangaroos in far western New South Wales and assessment of ecological effects., Johannes Gutenberg University.

Bilton AD (2004) Determinants of reproductive success in female red kangaroos (*Macropus rufus*). PhD thesis, University of NSW.

Bilton AD, Croft DB (2004) Lifetime reproductive success in a population of female red kangaroos *Macropus rufus* in the sheep rangelands of western New South Wales: Environmental effects and population dynamics. *Australian Mammalogy* **26**, 45-60.

Choi C (2004) Behaviour of raptors, ravens and crows feeding at animal carcasses. BSc. (Hons) thesis, University of NSW.

Croft DB (2004) Kangaroo management: individuals and communities. *Australian Mammalogy* **26**, 101-108.

Dawson TJ, Maloney SK (2004) Fur versus feathers: the different roles of red kangaroo fur and emu feathers in thermoregulation in the Australian arid zone. *Australian Mammalogy* **26**, 145-152.

Dawson TJ, McTavish K, Ellis BA (2004) Diets and foraging behaviour of red and eastern grey kangaroos in arid shrub land: is feeding behaviour involved in the range expansion of the eastern grey kangaroo into the arid zone? *Australian Mammalogy* **26**, 169-178.

Dawson TJ, Mifsud B, Raad MC, Webster KN (2004) Aerobic characteristics of red kangaroo skeletal muscles: is a high aerobic capacity matched by muscle mitochondrial and capillary morphology as in placental mammals? *Journal of Experimental Biology* **207**, 2811-2821.

Higginbottom KB, Northope CL, Croft DB, Hill B, Fredline E (2004) The role of kangaroos in Australian tourism. *Australian Mammalogy* **26**, 23-31.

Hill SM, Roach IC, Field JB (2004) A collaborative undergraduate field school for regolith geoscience at Fowlers Gap, western NSW: 2004 a regolith odyssey. In 'Advances in Regolith'. (Ed. IC Roach) pp. 134-139. (Cooperative Research Centre for Landscape Evolution and Mining Engineering: Canberra)

Hulbert AJ, Else PL (2004) Mammalian metabolism: insights from arid zone reptiles. *Australian Mammalogy* **26**, 111-116.

Lee E, Kloecker U, Croft DB, Ramp D (2004) Kangaroo-vehicle collisions in Australia's sheep rangelands, during and following drought periods. *Australian Mammalogy* **26**, 215-226.

Munn AJ, Dawson TJ (2004) The ecophysiology of survival in juvenile red kangaroos *Macropus rufus*: Greater demands and higher costs. *Australian Mammalogy* **26**, 161-168.

Turner JM (2004) The effects of European rabbit (*Oryctolagus cuniculus* L.) disturbance on invertebrate assemblages, with a focus on ants, at Fowlers Gap in the semi-arid zone of northwestern New South Wales. BSc. (Hons) thesis, University of New South Wales.

Webster KN, Dawson TJ (2004) Is the energetics of mammalian hopping locomotion advantageous in arid environments? *Australian Mammalogy* **26**, 153-160.

2005:

Bambrook S (2005) Solar photovoltaic pumping. BEng. Honours thesis, University of NSW.

Brazill-Boast J (2005) Mate choice in the zebra finch: has domestication affected sexual preference? BSc. (Hons). thesis, University of NSW.

Croft DB (2005a) The future of kangaroos - Going, going, Gone? In 'Kangaroos: Myths and Realities'. (Eds M Wilson and DB Croft) pp. 223-244. (Australian Wildlife Protection Council: Melbourne)

Croft DB (2005b) Kangaroos maligned - 16 million years of evolution and two centuries of persecution. In 'Kangaroos: Myths and Realities'. (Eds M Wilson and DB Croft) pp. 17-32. (Australian Wildlife Protection Council: Melbourne)

Frank A, Soderquist T (2005) The importance of refuge habitat in the local conservation of stripe-faced dunnarts, *Sminthopsis macroura* on arid rangelands. *Australian Mammalogy* **27**, 75-79.

Hill SM (2005) Regolith and landscape evolution of far western New South Wales. In 'Regolith landscape evolution across Australia: A compilation of regolith landscape case studies with regolith landscape evolution models'. (Eds RR Anand and P De Broekert) pp. 130-146. (Cooperative Research Centre for Landscape Environments and Mineral Exploration.: Perth)

Hill SM, Roach IC (2005) The regolith-landforms of northern Lake Paddock, Fowlers Gap, western NSW. In 'Regolith 2005 - Ten Years of CRC LEME'. (Ed. IC Roach) pp. 139-145. (Cooperative Research Centre for Landscape Environments and Mineral Exploration: Canberra)

Portelli DJ (2005) The socioecology of the cooperatively-breeding chestnut-crowned babbler (*Pomatostomus ruficeps*). BSc. (Hons) thesis, University of New South Wales.

Wakelin-King GA (2005) Modern fluvial process and prior landscape history in an arid-zone river: Fowlers Creek, New South Wales, Australia. PhD thesis, LaTrobe University.

Witte I (2005) Kangaroos - Misunderstood and maligned reproductive miracle workers. In 'Kangaroos: Myths and Realities'. (Eds M Wilson and DB Croft) pp. 118-207. (Australian Wildlife Protection Council: Melbourne)

2006:

Dawson TJ, McTavish KJ, Munn AJ, Holloway J (2006) Water use and the thermoregulatory behaviour of kangaroos in arid regions: insights into the colonisation of arid rangelands in Australia by the Eastern Grey Kangaroo (*Macropus giganteus*). *Journal of Comparative Physiology B Biochemical Systemic & Environmental Physiology* **176**, 45-53.

Gebauer K (2006) Using olfactory stimuli to reduce animal-vehicle collisions: Aversive properties of the dingo bush (*Eremophila microtheca*) for macropods. Diploma thesis, University of Potsdam.

Kloecker U, Croft DB, Ramp D (2006) Frequency and causes of kangaroo-vehicle collisions on an Australian outback highway. *Wildlife Research* **33**, 5-15.

Munn AJ, Dawson TJ (2006) Forage fibre digestion, rates of feed passage and gut fill in juvenile and adult red kangaroos *Macropus rufus* Desmarest: why body size matters. *Journal of Experimental Biology* **209**, 1535-1547.

Munn AJ, Dawson TJ, Hume ID (2006) Endogenous nitrogen excretion by red kangaroos (*Macropus rufus*): Effects of animal age and forage quality. *Physiological & Biochemical Zoology* **79**, 424-436.

Roberts EM, Croft DB (2006) 'Evaluation of alternative ram types for lamb breeder-finisher systems in the low rainfall zone.' Meat and Livestock Australia, Sydney.