1 Research Reports – 2008

1.1 Guidelines for the kangaroo whisperer: ways to minimize disturbance during kangaroo observations by foot and car

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We examined how tourists approach free-living kangaroos during encounters in a popular Outback tourism destination, the Flinders Ranges of South Australia. We then simulated the typical properties of approaches to quantify the behavioural reactions of Red Kangaroos (*Macropus rufus*) and Euros (*M. robustus erubescens*) and the relation to the disturbance context (including species, sex class, group size, time of day, cover, and wind speed).

Approach varied by access (on-trail, off-trail), transport (on-trail: hiking, driving; off-trail: hiking) and approach style (on-trail: tangential/continuous, tangential/stop-and-go; off-trail: direct/continuous, direct/stop-and-go, direct/stop-and-go/talking, tangential/switchbacks/stop-and-go). On-trail, 53% of kangaroos took flight when the closest distance to them was approached or attained whilst (by design) all subjects off-trail took flight. The mean (+ 1 SE) flight initiation distance (FID) was significantly shorter following an on-trail (78 ± 2.7 m) than an off-trail approach (90 ± 2.7 m). Kangaroos fled less often (41% vs. 75%) and spent more time in maintenance activities (40% vs. 10%) if approached in a vehicle than on foot. The mean FID and flight path (FP) after approach on foot was reduced when made in a stop-and-go fashion. Euros fled at a significantly shorter FID along a shorter FP than Red Kangaroos. FID was longest in females with young-at-foot and shortest in females with obvious pouch-young. Viewing distance was closest if the approach was made in the evenings, if the habitat provided cover and the day was calm.

The varying intrusiveness of the different approach styles is attributed to differences in the previous experience with similar disturbance, the predictability, directness and continuity of the approach as well as changes in approach direction, additional behaviour such as talking and the disturbance context. The results suggest that wildlife tourists should be educated to the best choice of approach behaviour and viewing conditions and thereby reduce aversive reactions in kangaroos and mediate closer observations to the visitors' greater satisfaction and the kangaroos' better welfare.

1.2 Wildlife by candlelight: a comparison of nocturnal observation techniques for their impact on wildlife and visitor satisfaction

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Nocturnal observation of wildlife is a highly popular tourist attraction. However, very little research exists about its impact on wildlife and thus the possible trade-off in minimizing impact and maximizing visitor satisfaction in night-time tours.

We recorded the species-abundance and observation distance of all mammal, bird and reptile species in 144 nocturnal observation periods of 1.5 h each near a homestead in the Australian rangelands. We compared the results achieved with different illumination equipment (white vs. red vs. infrared light/night vision device), watch modes (sitting at artificial watering points vs. hiking in creek beds), observation times (starting at vs. 2 h past dusk) and wind speed. Further, kangaroo and bird behaviour were analysed in relation to the different illumination techniques. We recorded a higher abundance and species richness of the non-bat fauna and a higher bat activity while sitting at artificial watering points directly after dusk during calm nights compared to the other observation conditions. Red light elicited a similar behavioural effect as white light of the same photometric intensity and both elicited activities indicative of disturbance and avoidance. A night vision device enhanced by infrared light facilitated closer observations and viewing of species which were seen less under white or red light. In addition, fewer kangaroos and birds were vigilant or took flight, and more time was spent with maintenance behaviour and social interactions.

In a questionnaire-based survey, the majority of our respondents had previously participated in night-time tours of Australian wildlife and conveyed their future interest in such tours. Engaging with night vision equipment and bat detectors was highly appealing. The preferred tours were those that combined a stationary observation at watering points with hiking along creek beds. Tours should involve an introductory talk of <15 min, commence directly after dusk and last 1–1.5 h. The most desirable group size included <8 participants. Numerous features of the wildlife viewed and the conduct of the tour determined satisfaction with night-time tours. Participants need to be educated on aversive effects on wildlife imposed by night-time tours as the majority assumed impacts to be low or very low.

We conclude that a satisfying fauna-viewing experience can accrue from a low-impact observation style using the optimal methods arising from our research.

1.3 Behaviour and ecology of the cooperatively breeding Apostlebird

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This long-term study of the apostlebird (*Struthidea cinerea*) population at Fowlers Gap has continued to progress. Over 350 birds have now been caught, individually colour-banded and bled (for genetic analyses of relatedness), representing approximately 95% of the birds in the 30 breeding groups within 15 'clans' in the core study area within ~5km of the station. We have succeeded in habituating 90% of these banded birds to the close presence of human observers. The aim now is to get all individuals in the core study area to stand on electronic balances on demand, so that we can measure short-term changes in body mass and hence assess state-dependence within- and between-individuals in their behavioural strategies. We now have 4

years data on the social structure, breeding group size and breeding success, including detailed GIS mapping of the creek habitat used for nesting. Additional banding and breeding data were collected in 2008 involving more than 15 additional breeding groups on the rest of the property outside the core area, such as in East Fowlers Gap Creek, Ochre House and Sandstone Tank. Detailed behavioural observations and experiments have continued on helping at the nest in the core area. Compared with populations further east, the social structure of the Fowlers Gap population of apostlebirds seems to be surprisingly fluid and rather flexible in terms of breeding group formation and reproductive effort, which both depend heavily on annual variation in environmental conditions. The large wide-ranging flocks seen during the winter at Fowlers Gap appear to constitute 'clans' of familiar and possibly related individuals. These non-breeding winter flocks fragment in the early spring and form smaller breeding groups of 3 to 15 individuals, and these breeding groups gradually join back together once breeding is over, reforming into the large winter flocks by the end of the summer. Birds often move repeatedly between breeding groups within a clan, sometimes between first and second breeding attempts, but most especially between breeding seasons. The more usual one-way long-distance dispersal (nearly always by females) also seems to occur between clans. There are some interesting implications here for variable patterns of familiarity and relatedness within and between breeding groups, which will form the basis of our study into the cooperative mating system and genetic structure of this population.

1.4 Vocal communication at nest between mates in wild zebra finches: a private vocal duet?

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We worked on vocalization in zebra finches breeding in nest boxes at gap Hills between September and October. Vocal duets are joint displays where two birds, generally a mated pair, produce temporally coordinated vocalizations. Duets may participate in pair-bond maintenance, mate guarding or collaborative defense of resources. Duetting shows a great diversity in the degree of coordination between mates and the variety of vocalizations. Only 3 to 7% of world-wide species have been reported to duet, perhaps because studies generally focused on conspicuous duets with high temporal precision. Thus, more private forms of duet might have been overlooked. Here we study private vocal communication between mates in wild zebra finches (*Taeniopygia guttata*). Zebra finches are Australian gregarious songbirds that form life-long pair-bonds. The partners are inseparable unless nest building, incubating or brooding. Using microphones inside nest boxes, we monitor interactive communication between partners at the nest and its variation along the reproductive stages. We show that, after separation periods, partners perform coordinated mutual vocal displays involving specific soft vocal elements. Using playback experiments, we demonstrate that these soft calls allow mate recognition. Thus, we propose that nest mutual displays in zebra finches represent private vocal duets and may function to mediate pair-bond maintenance.

1.5 The evolution of sociality in the zebra finch

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Coloniality is a puzzling habitat use strategy because it challenges the idea that fitness decreases with increasing density. If living at high density is costly, we then expect coloniality to bring some benefits. For instance, neighbours at a colony may exchange information about food patch location.

Here we used an experimental approach to investigate the foraging costs and benefits of coloniality in wild zebra finch in its native habitat. We manipulated nest site and food location and brood size to compare the foraging strategies of 90 colonial and solitary pairs. We provided birds with ad-libitum seeds in 5 feeders scattered in the study area, and change their location every 7 days. In total, 150 adults were fitted with a transponder tag and their visits to the active feeders and to their nest were automatically recorded throughout the three-month breeding period. We could then determine whether birds foraged optimally, how fast each individual find a new food patch, and how foraging behaviour affected chick-provisioning rate.

Individuals did not follow the Ideal Free Distribution: some feeders were disproportionately popular and birds did not forage in the feeder closer to their nest. Moreover, contrarily to our prediction, solitary pairs found the feeders faster than colonial birds and were able to provide more food to their chicks when brood were enlarged. For most feeders, we could not identify clear channels of information transfer among breeding birds when mapping the nest location of the birds that successively found the feeder. We still need to investigate whether some neighbours at the colony forage together by trying to identify association patterns at the feeders and synchronisation of nest visits within each colony. Within a pair, we found that partners that visit their nest together more often had a higher reproductive success.
Further research is needed to test whether individuals chose a nest site according to their foraging capacities: Good foragers may settle in solitary nests because they can find food by themselves whereas birds that rely on others to find food may prefer settling in colonies. Our results raise interesting questions about the influence of social factors on foraging strategy and may partly explain its departure from optimality.

1.6 Growth rates and maternal effects in the wild zebra finch

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This work followed up on previous studies that had been conducted on captive birds in the UK and Australia on synchronous and asynchronous hatching in zebra finches. The synchrony of hatching can greatly influence competitive dynamics within the nest, with asynchronous hatching producing chicks that have a size advantage over their siblings, greatly decreasing the younger individuals' ability to compete with their older siblings for limited resources. The physiological mechanisms that produce an egg in a female limit laying to one a day. However female manipulation of the developmental time of different eggs within a laying sequence, and

controlling the onset of incubation, can lead to synchronous broods. In captivity hatching is often asynchronous, whilst observations in the wild have shown hatching to be very synchronous. To investigate any selective benefit for synchronous nests in the wild, we removed eggs from wild zebra finch eggs the day they were laid and replaced them with a dummy egg. Eggs were then artificial incubated in either a synchronous, all at the same time, or an asynchronous order, where half the clutch was incubated 48 hours before the second half. Chicks were returned to nests as they hatched and measured daily. Nest box cameras were also used to obtain begging behaviour and reveal any preferential feeding by parents. Comparisons between individual growth rates and competitive dynamics within the nest were then compared between the two treatments.

1.7 No obvious function of extreme variation in egg patterning among chestnut-crowned babblers

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The morphology of bird eggs can vary dramatically both between and within species. Despite wide-ranging attempts to explain eggshell polymorphism, we still do not know the extent to which this variation is beneficial. For example, while many cavity nesters have white eggs and many ground nesters have cryptic eggs, there are countless exceptions; the degree of egg camouflage appears to have more to do with where the eggs are laid rather than their colour or patterning *per se*. Although less common, variation can also be extreme within species, and again several explanations have been proposed, including: crypsis, brood parasitism, and soil chemistry.

We tested these alternative hypotheses in the chestnut-crowned babbler at the UNSW arid zone research station, Fowlers Gap. Babbler eggs are tremendously variable, ranging in colour from beige to olive green to chocolate brown, and exhibiting unique combinations of speckles and stripes. During 2006 and 2007, we measured and photographed 410 eggs from 120 clutches laid by 50 females in 50 groups and conducted model egg experiments involving combinations of realistic-looking and white model eggs. Specifically, we investigated: (1) whether egg characteristics varied as a function of female identity or habitat type; (2) whether they varied to facilitate crypsis or brood parasite identification; and (3) whether they vary as a function of underlying geology.

We were able to reject the crypsis hypothesis outright: babblers always lay highly pigmented eggs, even though they use dome nests that are completely dark inside. Within females, we found high repeatability both within and between clutches for many eggshell characteristics, suggesting that intraspecific brood parasitism might be acting as a selection pressure in this population. However, females did not reject white model eggs at a higher rate than realistic model eggs, indicating that brood parasitism is probably not playing a central role in eggshell diversification. Finally, when we analysed geology, soil and vegetation features using GIS software, we found no relationship between underlying geology or habitat and any eggshell traits. We suggest that variation in egg-shell patterning might often have no current function, and we should be careful not to invoke functional explanations without careful consideration of unselected possibilities.

1.8 Big eggs are better in Chestnut-crowned Babblers

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Human babies differ enormously in size at birth. In humans which live without modern medicine and health care, big babies are normally more likely to survive than small babies. These results suggest that mothers in such societies should give birth to big babies. However, the importance of being large at birth in humans, and other mammals, cannot be distinguished from the effects of age; large babies are likely to be older, but the exact age is seldom known because of difficulties in determining exact date at conception. By contrast, in birds, mothers provision their offspring with discrete amounts of food in the form of eggs and lay-dates can be determined with precision. Using these facts, we can determine the importance of body size per se at hatching on hatching success, growth and subsequent survival.

A bird's egg contains all the nutrients that a young bird needs for the first part of its life. Unsurprisingly, eggs laid by different females within the same population vary dramatically in size, in part reflecting differences in a mother's ability to provision her eggs with costly protein, fat and carbohydrate. Despite the common observation that eggs vary in size between different nests, relatively few studies have attempted to determine whether offspring from large eggs are more successful than those from small eggs. In order to test this possibility we removed eggs from 50 nests of chestnut-crowned babblers at the UNSW arid zone research station at Fowlers Gap, and hatched the eggs artificially in incubators. In all nests, real eggs were replaced with the same number of model eggs, and the females continued to incubate as normal. The size of the chick that hatched from each egg was related closely to the size of the egg, indicating that large eggs give rise to large chicks.

We then returned chicks back to nests, such that each nest contained 4 chicks, all from different nests. I found that chicks that hatched from large eggs were more likely to survive to fledging, grew faster and were still heavier at fledging. These results suggest that big eggs are better and lead to the questions of why eggs vary in size, how egg size and clutch size co-vary and what factors influence egg size in babblers? These questions will be addressed using 6-years of data on egg sizes collected at Fowlers Gap so far, in addition to information on territory quality, rainfall, female age and condition and group size.

1.9 Why live in a family? Insights from the cooperatively breeding chestnut-crowned babbler

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Cooperative breeding, wherein individuals in addition to the reproductive pair assist with rearing offspring, is a relatively rare social system amongst animals, and its evolution and maintenance have been the focus of extensive research. Kinship has long been suggested to be a crucial factor for the evolution of cooperative systems and group living, providing genetic benefits for cooperative acts, but less well resolved are the relative contributions of other non-genetic benefits and the impact of cooperation costs. The chestnut-crowned babbler, a passerine endemic to arid SE Australia, represents an ideal model system to investigate the

aforementioned issues. Using a combination of behavioral observations, field experiments, spatial analysis and lab genotyping, our research is trying to clarify interplays between genetics, ecological variables and life history traits in shaping the species' social and breeding system. In the course of 2008, we have spent more than six months at Fowlers Gap Research station, investigating the social system and behaviour in babblers. In particular, we have collected a significant amount of data on the species' spatial organisation, including details of home range sizes, distributions and overlaps from a total of 45 social groups. A number of playback experiments, simulating territorial intrusions of neighbour as well as foreign groups, have also been performed. Preliminary data analysis has revelead that variation in response to playbacks seems to be associated with focal group size and appears also to be affected by playback group size and acquaintance with the simulated groups (neighbour vs foreigner effect). In 2009, we plan to continue with home range data collections and experiments, and increase the amount of data collected through resempling of previously investigated groups as well as inclusion of new ones in an extended study area.

1.10 University of Adelaide's Fowlers Gap Regolith and Landscape Studies in 2009

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The University of Adelaide's Regolith and Landscape Evolution 2nd year undergraduate field trip was held at Fowlers Gap between July 7-11, 2009. The objective of the fieldtrip was to introduce the students to the excellent examples of regolith and soil materials and their close associations with landforms in the area. Students also gain first-hand experience in the field description and sampling for pedology, plant biogeochemistry and geophysics. Approximately 100 undergraduate students attended the fieldtrip with 3 academic staff members supported by a group of demonstrators.

The first day of the trip included a field traverse from the Barrier Ranges to the Lake Bancannia Plains. This traverse commenced near the Fowlers Gap station buildings and approximates the powerline towards the NE and onto the plains. It then returns to the station following the course of Fowlers Creek. Students use an evolving set of teaching notes and the recently published Connors and Hotel regolith-landform maps to highlight field "stations" along the traverse. The field stations indicate some of the key landscape features of the region and many sites included a field demonstration from a teaching staff member. Highlights of the traverse include:

1. Leopardwood trees and their links to palaeo-vegetation communities;
2. ferruginised regolith and chenopod shrubs;
3. Faraway Hills Quartzite and its association with ridgeline topography;
4. Curly mallee and geobotanical associations with Adelaidean dolomite and basalt;
5. Devonian sedimentary rocks;
6. Young tectonism, silcretes and Mesozoic marine sediments;
7. Stream terraces along Fowlers Creek;
8. Saline scalding near the Homestead Creek – Fowlers Creek junction; and,

9. field demonstrations of soil pit descriptions, geophysical measurements and plant biogeochemistry sampling.

The remaining field days included regolith-landform mapping immediately west of the station buildings and along Homestead Creek, as well as river red gum leaf sampling from trees along Homestead Creek. A series of soil pits were excavated and described across South Ridge in the mapping area. Field samples and mapping data form a major component of practical sessions held at the university during the following semester.

In the following year it is planned to further evolved the teaching notes to accompany the field traverse, as well as continue the mapping and soil pit program across adjoining areas.

1.11 Role of soil factors in ecohydrology and landscape function at Fowlers Gap.

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Recent fieldwork has focussed on the patterned chenopod shrublands in Hotel paddock, which drains to the left-hand bank of Fowlers Creek. This area displays plant cover that takes the form of contour-aligned groves, separated by bare intergroves. Such landscapes exhibit primarily local runoff that arises on the bare intergroves and drains downslope into the adjacent grove, where it is partly or wholly absorbed, increasing the amount of water available to support plant growth. The different hydrology of intergroves and groves is often claimed to arise directly and indirectly from the uneven plant cover. In groves, for example, the plants create sheltered microenvironments and it is suggested that burrowing organisms there contribute to better soil permeability. In detail, however, the role of soil factors in the ecohydrology of patterned plant communities remains relatively unexplored.

Soil data of various kinds have been collected along several transects through Hotel paddock. Soil permeability measurements have been made using conventional cylinder infiltrometry, in which a small pool of water is maintained at the soil surface and its rate of percolation into the soil is recorded. However, this fails to reproduce the effects of rain striking the soil surface. Therefore, duplicate measurements have also been made using a dripper infiltrometer, a more complex method in which artificial rain is released onto the soil at controlled rates, and the amount absorbed is recorded. The experiments were mostly run at a rainfall rate of 10 mm per hour.

Results have shown clearly that two kinds of soil surface seals or crusts are of great importance, and their influence on soil water may well exceed that of the plants. One kind, a *raindrop impact seal*, is produced by the repeated drop impacts during rain. The uppermost soil is changed structurally, and pore spaces are either lost or reduced in size by denser packing of the component mineral grains. The second soil surface crust is produced by soil algae that become active only when the soil is moist. At Fowlers Gap, grazing pressure has reduced the abundance of some kinds of susceptible crust organisms, but cyanobacteria remain very widespread, and can rapidly recolonise disturbed soils.

Both kinds of soil surface features have been explored using scanning electron microscopy (SEM) to examine soil samples from Hotel paddock, including samples that were exposed to

artificial rain. Results suggest that ecohydrologic response of these soils is modified by the properties of the uppermost few hundred micrometres. Most importantly, the intergrove soils exhibit both features most strongly and extensively, and may hold the key to water availability for the groves. The cyanobacterial crusts, for example, are associated with extensive mats of extracellular compounds (proteins, carbohydrates, etc.) that bind the mineral fragments into stable structures that resist raindrop impact. In addition, the algal filaments entangle the soil particles and this confers additional stability against both wind and water erosion. Both kinds of crust are easily damaged mechanically, but can redevelop quickly if disturbance is not continuous. Thus, the ecohydrology of the patterned shrublands appears to be linked to the properties of the uppermost few millimetres of the soil. Within groves, the spatial continuity of the soil surface crusts is reduced because the soils expand when wet, and shrink when dry. This soil instability fragments the crusts and leaves some areas with no crust development. In these areas, the uptake of rain and runon water is enhanced. In the bare intergroves, the soils remain dry, and hence do not exhibit the shrink-swell behaviour. Crusts there are consequently continuous over the entire surface, creating an extensive runoff source. In both grove and intergrove zones, therefore, a key role for these thin soil crusts can be seen. These results will be used to guide the development of a revised conception of how the patterned shrublands operate in terms of water redistribution that focusses greater attention on soil properties, and which seeks to re-evaluate the role of the vascular plants.

1.12 Field metabolic rate and water turnover of free ranging red kangaroos and merino sheep in an arid rangeland

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How much energy (food) and water do red kangaroos and merino sheep use in the field? This important question provides insight into the potential differences in grazing pressures that may be exerted by these herbivores. We measured the field metabolic rate (kJ d^{-1}) and water turnover (L d^{-1}) of n = 6 red kangaroos (*Macropus rufus*) and n = 6 merino sheep (*Ovis aries*) using the doubly labelled water (DLW) method. After initial capture by darting and processing with DLW the red kangaroos were released at point of capture and allowed to range freely across Fowlers Gap. Sheep were mustered as per standard procedures, processed with DLW and released into a typical paddock at Fowlers gap. Animal movements were logged using GPS technology and all animals were re-captured after 6-10 days. Initial data analyses indicate that with respect to energy intake (kJ d^{-1}), a standard 25 kg red kangaroo is equivalent to approximately 0.3 standard (45 kg) sheep, and they use only 12-15% as much water. We are currently investigating the free-ranging movements and activity patterns of the sheep and kangaroos to determine how much locomotive costs might drive this difference in kangaroo and sheep resource requirements. This work was funded in part by the Australian Research Council (Linkage), the NSW DECC Kangaroo Management Program (KMP), The SA DEH KMP, the WA CALM KMP, The NSW Western Catchments management Authority, The NSW DPI and the National Geographic Society.

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