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Fowlers Gap
Arid Zone Research Station

1 Research Reports – 2003

Effects of upbringing and experience on herbivore diet selection in the Australian arid rangelands: Comparison between red and western grey kangaroos

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Mammalian herbivores like sheep and kangaroos have to contend with a plethora of plant defences included physical ones, like spines, and chemical ones, like digestion inhibitors (e.g. tannins) and poisons (e.g. alkaloids, cyanide compounds, nitrates, terpenes). A juvenile kangaroo or lamb can learn about what to eat and what to avoid by trial and error (e.g. does it taste bad, does it induce sickness, does it satisfy energy and nutrient requirements) and/or social learning (e.g. mimicking the foraging behaviour of its mother or peers). Young kangaroos have an advantage over lambs in that they get to do a lot of observing of their mother's diet choices in their later stages of pouch life. Those that are orphaned and reared by a human carer will miss much of this experience. We are investigating this issue with hand-reared and wild mother-reared juvenile western grey and red kangaroos on Fowlers Gap. Western greys were chosen as the principal subjects as they have the broadest diet of the four kangaroo species in the far west. Noemi is following the juveniles around while they forage recording each species of plant eaten, the number of bites and the part cropped. She will determine whether the inexperienced hand-reared ones are neophobic (afraid of the new) or cavalier (try anything once) and how their foraging efficiency compares with mother-reared juveniles. Mammalian herbivores will eat a broad diet (variety is the spice of life) if they need to dilute the various toxins so that no one plant type delivers a lethal dose. Noemi will discover the degree to which this skill is learnt from observation of the mother and other role models.

Saving Wildlife- Saving People on Our Roads

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Kangaroo-vehicle collisions kill many thousands of kangaroos and wallabies in Australia. People also suffer via stress, anxiety, injuries and motor vehicle damage. In spite of the magnitude of this problem, there is a lack of information on the patterns, causes, and effects of kangaroo-vehicle collisions. To gain insight into this problem, we have investigated such collisions along the 21.2 km sealed section of the Silver City Highway passing through Fowlers Gap. Two six-month studies (February – July 2002 and 2003) during and following severe drought have been completed by Diploma student Ulrike Kloecker (University of Bonn) and PhD student Enhua Lee (UNSW), respectively. They recorded the species, sex and age of each road-killed kangaroo and the following possible causal variables:

- roadside features of the roadkill sites (water sources, road cuttings, curves, and stock races)
- vegetation composition and structure of road side verge at kill and random sites
- traffic along the highway (volume, speed and vehicle type)
- weather
- population densities of each kangaroo species along the road and 500 m away in the hinterland during the night and early morning.

In the 2002 drought period, 20.8 roadkills per month of predominantly red kangaroos were recorded but this fell to only 2.2 per month in the 2003 post-drought period. Vegetation cover and greenness were higher at the road edge compared to 30 meters away from the road during drough**t.** Kangaroo densities were higher along the road compared to the hinterland during drought but the opposite trend was found for the post-drought period. Traffic along the highway was similar for both sampling periods. However during drought the best predictor of roadkill was night-time traffic volume. We concluded that

- Mitigation measures against kangaroo-vehicle collisions should be concentrated on curves and stockraces along the road where driver visibility is poor and the attraction on the roadside verge should be further investigated.
- Efforts to reduce roadkills over time should take environmental conditions into account, as the influences of temporal causal factors change during and following periods of drought.
- Models predicting roadkill frequency will be inaccurate if only one environmental condition is considered.

Enhua Lee will continue this study through 2003-4 and will a focus on the ecological effects of the road in an arid landscape. The study is part of a state-wide investigation of the causes and ways to prevent wildlife-vehicle collisions lead by Dr Dan Ramp and Dr David Croft at UNSW.

Behaviour of raptors, ravens and crows feeding at animal carcasses

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We are investigating the behaviour of scavenging birds – raptors such as wedge-tail eagles and black kites, Australian ravens and little crows – at animal carcasses beside the road or in the hinterland. The first objective is to determine whether scavenging birds aggregate along roads where road-killed kangaroos and livestock can be found. We are therefore monitoring the density of raptors, ravens and crows along the 21.2 km stretch of the Silver City Highway through Fowlers Gap and comparing these densities to those along a 53.5 km circular route through the hinterland of the Station. The second objective is to determine the behaviour of birds at a carcass and the degree of intra- and interspecific competition. We are therefore recording behaviour at carcasses with time-lapse video using a colour camera in the daylight with B/W infra illumination at night to examine offtake from the carcass by other scavengers like foxes, cats and pigs. The third objective is to determine risk of secondary kills of scavengers on road-kills resulting from wildlife-vehicle collision. We are therefore using the same video recording with the highway in view to examine the response of birds feeding on carcasses to passing vehicles. Vehicle type and speed is monitored with a road surface mounted counter. Our final objective is to examine the dynamics of foraging at carcasses. We are analysing the videotape records of behaviour to determine whether there is social facilitation of feeding (i.e. as the number of birds increases at the carcass it becomes more obvious and attracts other conspecifics or more dominant species).

Threads or filaments in surface runoff: the nature of fluid motion in shallow overland flow

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A common view of hydrological response to rain in drylands is that it involves widespread Hortonian overland flow. This is surface runoff that results when rain arrives at the soil surface faster than it can be absorbed, forcing some to remain on the surface and to drain away across it. Both intense thunderstorm rain and bare, crusted, impervious soils tend to promote this kind of runoff. Such a view of dryland runoff production is an oversimplification, because almost everywhere the soil surface is really a patchwork of different materials, and some soils (notably those beneath shrub canopies) can in fact absorb water with great rapidity. Nevertheless, surface runoff is locally a distinguishing feature of many drylands, and one that is rarely seen, for example, in many forests of the humid zone.

Widespread surface runoff brings with it the potential for associated erosion of soil particles, seeds, or organic litter. Many studies have attempted to relate the properties of surface runoff, like its depth or its speed of flow, to the severity of any associated erosion. But much of this work has relied on simplifying assumptions, notably that surface runoff can be described technically as being uniform flow, with constant depth and speed that are mutually adjusted. This is almost certainly never the case, since soil surfaces are uneven, and flow gathers in low-lying tracks across it, where the flow is both deeper and faster than elsewhere. These local zones of concentrated flow are termed flow threads or flow filaments. Though their existence was noted in experimental work carried out on grazing land in Wyoming more than 30 years ago, little has been learned since. The importance of threads is that they have the potential to be zones of concentrated soil entrainment and erosion, and not just concentrated water flow. Experiments carried out at Fowlers Gap to explore these ideas are among the first detailed studies of flow threads.

Bare soil surfaces with as little irregularity as possible were chosen, and subjected to a series of runoff experiments in which water was fed at controlled rates from a 1000-litre tank. Flow properties including depth and speed were measured frequently during the runoff, and related to the detailed form of the soil surface. The latter was described by preparing detailed contour maps, with contours at 1 mm height intervals, with a computer-controlled measuring system.

The results, which are accepted for publication and which will appear in print late in 2004, show very marked development of flow threads even where the soil surface appeared smooth. Evidently, even small fluctuations in level are sufficient to concentrate the shallow flows found during storm runoff. Average thread speeds were shown to average 2.5 x the flow-field mean speed (that of the flow taken as a whole), and to locally reach 6 – 7 x that value. On the other hand, non-thread flow speeds were consistently lower than the flow-field mean, typically only reaching 84% of that value. Thread and non-thread speeds formed statistically distinct populations. Mean depths on threads were 2.4 x the depth in non-thread zones. Very detailed measurements were required to show the existence of these deep and fast regions within the flow. Ordinarily in erosional research, they would pass unrecorded.

Overall, about 63% of the flow passed across the experimental soil plots in flow threads that only occupied about 20% of the plot width. The residual 37% of the flow was conveyed in the shallower and slower-moving 80% of the plot width that forms the non-thread zone.

Statistically distinct estimates of Darcy-Weisbach friction coefficient, a measure of the drag arising from the soil surface, were derived for thread and non-thread flows. These were $f = 2.23$ (threads) and $f = 16.2$ (non-threads). The conventional flow-field mean value was $f = 10.3$, lying between these two values. Threads are evidently locations of much reduced frictional drag, and this permits the faster flow speeds to arise.

These results have clear implications for studies of surface runoff hydraulics and soil erosion. Since flow threads are relatively deep and fast, they are probably the main avenues for the conveyance of eroded soil particles. When their presence is concealed though a reliance on flow-field mean properties of flow, it would be unsurprising if the explanatory power of the flow data was poor. Much stronger correlations among soil loss from experimental erosion plots and flow properties may result if the flow properties used are those relating to the flow threads.

Publications:

Dunkerley D.L. 2003 (a). 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.

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

Regolith Mapping of Fowlers Gap

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Put simply, regolith is "everything between fresh rock and fresh air". Regolith includes all the surface materials above fresh rock, including weathered rock, soils, water, plants end even people. We depend on the regolith for the crops we eat, the clothes we wear and for the mineral resources contained within it or hidden underneath it. The regolith also contains many of the hazards that are becoming increasingly important to our continued survival such as dryland salinity, acid sulfate soils, soil degradation and erosion.

The Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), acting for the Minerals Tertiary Educations Council (MTEC, the tertiary education group of the Minerals Council of Australia) chose Fowlers Gap as an ideal site for teaching tertiary students and professionals about the regolith from the perspectives of mineral explorers and land mangers. In August 2003 CRC LEME ran a Masters-level course on "Regolith Geology and Mineral Exploration" and in March 2004 "Regolith Mapping and Field Techniques". Both courses teach people to recognise regolith materials and their landscape settings within arid Australia. Participants in the Masters course came from all states and territories of Australia and also from Holland and Tanzania, including postgraduate students from JCU, Macquarie University, UWA, UTas, University of Adelaide, ANU and industry professionals from NT Geological Survey, Geological Survey of Victoria, Noranda and CSIRO. Students in the Honours course came from Adelaide, Melbourne, Monash, ANU, Macquarie and Wollongong universities. In the post-course questionnaire, all of the students commented on the wonderful setting and quality of care at Fowlers Gap. They all enjoyed their time spent there, and regarded Fowlers Gap as an oasis in the middle of the bush (especially those who got to use the pool).

The approach used by CRC LEME towards teaching has been one of combining classroom lectures with fieldwork. The fieldwork has included visiting sites of regional regolith and landscape significance around the local area, as far as Tibooburra, White Cliffs and Broken Hill/Silverton, as well as systematically mapping the regolith and landforms of several of the paddocks on the station. This mapping is being conducted at 1:25,000 scale and adds considerable detail and refinement to the existing Land Systems maps of the station. The first paddock to be mapped was Sandstone (including West Sandstone) and the following year (2004-5) mapping has commenced in South Sandstone. The completed maps will be issued as a series of CRC LEME reports and will also be available as a GIS layer to Fowlers Gap staff.

Highlights of the mapping have included: greater subdivision and understanding of the interactions between surficial regolith materials and landforms; the mapping of an ancient palaeovalley system extending south-to-north through Sandstone Paddock; and the understanding of the long-term regolith and landscape evolution of the region. A short paper has been published from this work (Hill & Roach 2003) and can be found in the proceedings of the CRC LEME's 2003 Regional Regolith Symposia.

Publications:

Hill S.M. & Roach I.C. 2003. The regolith-landforms of Sandstone Paddock, Fowlers Gap, western NSW. *In:* Roach I.C. ed. *Advances in Regolith*. p 193-200. CRC LEME. ISBN 0-7315-4815-9 (CD-ROM)/0-7315-5221-0 (print). Available from CRC LEME http://crcleme.org.au/.

The Role of Shrink-Swell Soils; an Investigation of the Fowlers Gap Patterned Ground

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Investigations at Fowlers Gap to relate the surface and subsurface soil properties of an area of patterned ground, revealed a strong correlation between the surface type and the linear shrinkage of the subsoils. The study was undertaken using a combination of field observation and sampling with laboratory analysis. Three trenches were dug and observation of the subsoils made as well as samples taken. These samples were tested using, XRD, XRF, LSmod, laser particle size analysis, micromorphology studies and SEM imaging. From this study it was concluded that patterned ground may be formed and maintained through a positive feedback system between vegetation and shrink-swell soils, and that shrink-swell behaviour was more intense under the vegetation than under the bare zones of this landscape.

Evaluation of alternative ram types for lamb breeder: finisher systems in the low rainfall zone

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The Project aims to compare sire types and examine a breeder and finisher system for producers in the low rainfall zone. Traditional Merino types will be compared for breeding of lambs from Merino ewes, and the lambs will be weaned and grown out on a property in South Australia which will have pasture suitable for growing out lambs.

The objectives are:

1. Generate lambs by three sources from Merino ewes bred and run under normal pastoral zone management at the Fowlers Gap research station.
2. Wean the lambs at an appropriate age and transfer to a finishing property in South Australia.
3. Obtain grow-out data on the lambs, allowing evaluation of the alternative sire types.

The experimental design is to use three similar paddocks to perform the following matings in mid-December 2003:

1. *Fowlers Gap Merino rams x 200 Fowlers Gap Merino ewes*
2. *Centre Plus rams (known EBVs) x 200 Fowlers Gap Merino ewes.*
3. *Leahcim Merino rams x 200 Fowlers Gap Merino ewes*

Mating mobs will be kept separate for 56 days for joining, and there after ultra sounding of ewes will used to assess ewes still not pregnant and late conceptions due to late cycling in a summer joining. This procedure will test the adequacy of 6 week versus 8 week joining in the pastoral zone under variable seasons.

At lambing, ewes will be put back into their joining paddocks for 42 days + 17days and weaned at an appropriate weight (about 25 kg fasted live weight). All ewes will boxed after lambing to avoid paddock effects. The number of lambs per sire group, and weaning weight of all lambs will be recorded.

Lambs will then be transported to Burra in one or more shipments depending on the season and their growth. There after all lambs will be weighed monthly until dispatch (3 weights expected including the final live weight). At dispatch ideally all lambs will go at the same time, but a back-up is to have two or more drafts for slaughter. Lambs will be live weighed a final time, and carcass weight and GR depth (or yield if available) are to be obtained from the works on each of the treatment groups**.**