1998 Fowlers Gap Research Report

Determinants of Reproductive Success in female Red Kangaroos

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Despite much research into the reproductive abilities, behaviour and overall ecology of the red kangaroo, very little is known of the variability of reproductive success in individual animals. This project aims to determine those factors that influence the reproductive success of female red kangaroos and subsequently the composition and dynamics of the whole population. We will determine the effect on reproductive success of: maternal quality, including age, body condition, maternal care and social rank; sex of the offspring; quality and biomass of vegetation in the home range; and the density of conspecifics and other mammalian herbivores in the habitat.

Currently 33 individuals have been fitted with radio-collars. The females range from 2 to 20 years of age, and all were caught in the Mating paddock where this study is centred. The research schedule involves radio-tracking these animals weekly to determine their home range and monitor their reproductive status. Behavioural observations are also made on mother and young to try to determine some index of maternal care. Body condition, determined at capture from weight, is continually monitored along with social rank by a time-lapse video recording system, in conjunction with a weighing platform at a water trough. Monthly population surveys are carried out, as well as seasonal vegetation surveys. A series of digital photographs of vegetation within fixed plots, taken every 6 weeks, throughout the study site is also used to monitor vegetation quality.

Fieldwork commenced in March of 1998 and will be completed by March 2001.

Parasites in Ants

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A pilot study on ants and their relationships with parasites involved a stay in Folwer's Gap Field Station by Prof.P.Schmid-Hempel, in November 1998

Hydrology and erosion mechanisms in patterned chenopod shrublands

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Rainfall simulation experiments begun in 1997 have been continued, in order to expand the available database and to explore further the role of gibbers, organic litter, and chenopod shrubs in influencing hydrologic and erosional behaviour. In a continuation of work on the properties of the immediate environs of chenopod shrubs, extensive work has been carried out in order to define what may be called the 'zone of influence' that surrounds these plants. Because of the dispersal of litter, organic matter and nutrients, and the spread of root channels and faunal burrowing, the presence of a shrub has been shown to be associated with altered hydrologic behaviour across a zone extending well beyond the limits of the canopy. To explore this, detailed transects running from the stems of shrubs and into the shrub interspace beyond the canopy have been sampled at close intervals. Parameters measured to date on these radial transects include soil shear strength, soil bulk density, and soil infiltration rate. Miniature cylinder infiltrometers (10 cm diameter) have been used to measure the infiltration rates. Because the soil surfaces are frequently quite fragile, and carry crusts that could be disturbed by the installation of conventional cylinder infiltrometers, the miniature devices have been bonded to the soil surface with a silastic adhesive. Some soil properties, such as bulk density, are relatively uniform with increasing radial distance from the stem. In contrast, shear strength is very low beneath the canopy, reaches a peak near the canopy margin, and declines again into the shrub interspace. The peak in strength appears to be associated with biological soil crusts. Infiltration rates are most rapid near the stem, and decline rapidly with increasing radial distance. The pattern of this decline is best fitted by a power function model of the form

$$\ln(\text{infiltration rate, mm/h}) = 4.228 - 0.425 \ln(\text{stem distance, cm})$$

This relationship, based on 71 infiltration tests, is statistically significant ($p = 0.0001$). It confirms that infiltration rates remain considerably above the lower shrub interspace value even at locations well beyond the boundaries of the plant canopy. For the bluebush specimens studied, the mean canopy radius was approximately 46 cm. Thus, the conventional use of canopy dimensions in order to parameterise the shrub environment may not adequately reflect this larger 'zone of influence'. Testing of the power function model in the explanation of hydrologic response of runoff plots containing shrubs is underway.

Soil bulk density has been determined using the pit-and-membrane method, modified by the use of an electronic soil-surface indicator probe that allows very precise filling of the pit to the original soil surface level. Similarly, infiltration rates are determined using cylinder infiltrometers in association with an electronic water level probe that permits ponding depths to be maintained very precisely. Water uptake rates are typically monitored at 60-second intervals for 30-60 minutes, in order to estimate the final infiltration rate. A remaining issue in this work is the correction of infiltration data for lateral seepage. At present, a simple geometric model has been applied to correct for this, but the procedure requires additional testing and validation.

The field program is supported by funding from the Australian Research Council.

Publications:

Dunkerley D.L. 1998. The effects of plant litter on sediment detachment and transport in the arid zone: rainfall simulation experiments at Fowlers Gap, NSW. Paper presented at the Eighth Biennial Conference, Australian and New Zealand Geomorphology Group, Goolwa, SA, November 15-20, 1998. Conference Abstracts p.18. (Compiler Prof. R. Bourman, University of South Australia).

An investigation of silcrete, ferricrete and the Telephone Creek formation at Fowlers Gap
Investigator: Adrian Fisher, School of Geography, UNSW, Sydney, NSW 2052

Gibson (1996) observed a shallow dipping Early Cretaceous sediment, on the eastern edge of the Barrier Ranges on Fowlers Gap Station. It has subsequently been termed the Telephone Creek Formation. Iron and silica cemented pods and horizons of ferricrete and silcrete were found to be dipping within this sediment. The small discontinuous outcrops of silcrete and ferricrete have a probable origin from groundwater discharge. The Telephone Creek Formation is unconformably overlying the Devonian Nundooka Sandstone, and is blanketed by the red clay sediments of the Bancannia Basin.

After correlation with the results of Baarda (1968) on the Planet Bancannia South No. 1 bore, the Formation appears to be a sequence (from youngest to oldest) of a finely laminated micaceous shale, through to a micaceous sandy conglomerate to a, micaceous grey shale. Since its deposition in fluvial and lacustrine conditions, the Formation has been deformed by down warping of the Bancannia Basin, or by tectonics. A fault offsetting the formation may exist in the area where Fowlers Creek cuts through the Barrier Ranges. Gibson (1997, 1998a, 1998b) has investigated the post-cretaceous tectonics.

Some high level beveled surfaces within the Barrier Ranges appear to be the surface trace of the Devonian - Cretaceous unconformity. Due to this surface, and extensive remnant surface gravel from the Formation existing across both sides of the Barrier Ranges, the Telephone Creek Formation seems to have previously had a much larger distribution. Outcrops are also present on the western side of the ranges, situated on Floods Creek Station. Mesozoic, possibly Early Cretaceous plant fossils were found in a ferricrete bed within this Floods Creek outcrop. This suggests strongly that the mesas and their underlying sediments are not part of the Tertiary duricrust, and brings into doubt the naming by Neef et al. (1995) of many outcrops of Tertiary sediments that exist in the area.

Ward et al. (1969) had previously identified Tertiary silcretes on Fowlers Gap Station. These small outcrops exist on the western side of the Station in Sandstone Paddock. They appear to be extremely different to the silcretes found within the Cretaceous sediments. A satisfactory explanation for the existence of the two varieties of silcretes has not yet been found.

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An investigation into soil hardpans at Fowlers Gap

Investigators: Adrian Fisher, School of Geography, UNSW, Sydney, NSW 2052

Silica cemented horizons in arid zone soils are commonly termed soil hardpans. They have been described in many arid and semi-arid areas throughout the world. In the United States of America Flach et al. (1973) conducted research into hardpans for the U.S. Department of Agriculture. They termed the silica cementation a duripan, and concluded that they are "most extensive in soils of very easily weatherable, noncrystalline parent materials, such as pyroclastics".

In Australia however, hardpans have been found on a wide variety of parent materials. Most research conducted on Australian hardpans has agreed with the hypothesis suggested by Teakle (1936). This was summarised by Lawrie (1973), who stated, "development of hardpans is due to the leaching of soluble silica into the subsoil after heavy but infrequent rains followed by long periods of intense dessication and dehydration of silica during dry conditions". Lawrie also states that the silica "has probably been transported in solution from siliceous sediments and from silica released by weathering of siliceous mantles of stone and gravel." Many researchers also propose a relationship between the soil hardpan and residual deep weathering profiles. Although these theories have been established, our understanding of how soil hardpans form is still incomplete.

Some research into hardpans at Fowlers Gap Station has been conducted by Chartres (1982, 1983, 1985). The work however was only preliminary, with 6 sample localities over north-western New South Wales, 2 of which were on Fowlers Gap Station. This differs greatly from the work done by Lawrie who gathered 55 samples along a 100km transect, north of White Cliffs.

The current research by myself hopes to build on the preliminary work of Chartres, through investigating the soil hardpans on Fowlers Gap Station, looking at both micromorphological and chemical properties of the hardpan soils. However, it is hoped that the proposed research will be able to clarify the relationship between soil hardpans and geomorphic position, through the detailed approach of Lawrie.

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The properties of chenopod patterned ground: An investigation of a rangeland landscape feature at Fowlers Gap

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The properties of and linkages between sorted-step, weakly sorted step, weakly contoured, and contour chenopod patterned ground were investigated. This complex association of patterned ground occurred on a pediment on the eastern flank of the Barrier Ranges in arid western New South Wales. The rehabilitation and management of these forms of chenopod patterned ground is also considered by assessing the impact of contour furrowing upon a similar area of contour patterned ground to the north.

The patterned ground complex were described using plant cover and microtopography from line transect data, low level air-photo interpretation and soil data from profiles within 4 trenches, sampled to include a full range of surface conditions across each of the four areas. Within the contour furrowed area, two sites, treated and untreated were similarly described, except the soil data was collected form points.

The accumulation of aeolian material during the Quaternary resulted in the formation of soils which have a high clay content with a shrink swell potential, that developed into gilgais. The topography of the pediment influenced the movements of these soils and produced the microtopography that shape the different forms of patterned ground at the site.

The concentration of the coarse fraction within the run-off areas is caused by the hydrological mosaic and soil water movement and the resulting up thrusting of stones within the run-off areas. The decreasing coarse fraction content with increasing slope length is explained by geomorphological and anthropogenic history of the site.

The pediment is made up of two geomorphic surfaces, the relict upper slope (sorted step patterned ground) and the lower fan slope (contour patterned ground). The pedogenic and the geomorphic history of the pediment area inextricably linked, and the upper slope soils have under gone more pedogenesis than the lower slope. There is a conspicuous absent of the red-brown hardpans from the soils of the site despite conditions conducive to their formation. The key in the control in the patterned ground system is the amount of water available for redistribution. The geomorphology and pedology of the pediment indicated the role of climate was an important factor in the formation of patterned ground.

The vegetation of the pediment has been significantly affected by the grazing history of the area. The pediment is characteristically bare, and the progressing downslope the amount of vegetation cover decreases by 4.01%. The covertype associations also vary downslope, the upper site is a copperburr-saltbush association, saltbush-copperburr association and the lowest site is a copperburr-grass-saltbush association. The greater amount of cover at the upper site is due to the greater amount of the water run-off water generated compared to lower sites. The decrease in the amount of saltbush cover is caused by the decreasing amounts of available nitrogen within the run-off areas. The nitrogen is fixed by algae, which grow under the quartz gravel lag. This lag decreases downslope and thus the saltbushes are unable to compete with the grass for the available nitrogen pool. The bioavailability of various micronutrients (Cu, Fe, Mn, Mo, Ni, Pb, and Zn) was found to be high but no firm conclusions could be drawn. However there was evidence that there is a redox differential between the run-off/run-on areas within the chenopod patterned ground system.

The differences between run-off/run-on areas in terms of infiltration and evaporation and evapo-transpiration has resulted in the formation of different soil properties. The run-off areas are "salt dumps" where soluble salts (Ca^{2+}, Mg^{2+}, K^+ & Na^+) are concentrated and the within the run-areas less concentrated. All the different forms have soluble salt mosaic.

Environmental physiology of juvenile red kangaroos: Thermal biology and digestive physiology

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Juvenile red kangaroos (Macropus rufus) have the highest mortality rate of any population cohort during times of environmental stress. Severe or prolonged drought for example determines recruitment into adult populations. This project is designed to examine the physiology of juvenile kangaroos at their most vulnerable ages: permanent pouch exit (250 days old) and weaning (360 days old). By looking at the thermal biology of juveniles we can derive their base energy and water requirements and determine how important these factors are in governing juvenile survival. Eventually, an understanding of the major factors influencing juvenile survival should indicate which environmental factors are most important for regulating the size and structure of adult populations.

Studies at Fowlers Gap over the past 30 years have suggested that food quality plays an important role in the foraging ecology of arid zone kangaroos. This is particularly so for the smaller, younger animals whose energy demands are higher than adults. Work conducted at the UNSW Kensington campus using animals obtained from Fowlers Gap is currently examining the efficiency of juvenile and adult animals in digesting poor quality feed. This will provide information about juvenile digestive constraints and food requirements which can later be used in developing and testing foraging models at Fowlers Gap.

Channel morphology along an arid-zone river: Fowlers Creek, western New South Wales, Australia

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Arid zone fluvial systems are not merely dry versions of "normal" rivers. They often carry very coarse sediments; they have extremely flashy discharge (very low to very high volumes of water flow); they have vegetation growing within the channel. These and other factors make arid zone fluvial processes qualitatively different from those in temperate climates. However there is relatively little research carried out on these types of rivers. Seventy percent of continental Australia lies within the arid zone, and we cannot effectively deal with these rivers unless we understand how they work.

A flowing river will alter its channel by repeated feedback mechanisms until it can perform its "task" (the transport of a given amount and size of sediment, within a given water flow) in the most energy-efficient way possible. Fluvial processes can alter channel slope (by depositing or eroding sediment, or changing its planform to cover more ground to descend the same distance); they can alter channel cross-section (by erosion or deposition in channel or banks). Therefore where a river’s processes cannot be directly observed, due to its isolation and the rarity of flow events, it is possible to understand its processes by examining channel cross-sections and planforms along its length.

Fowlers Creek is 55 km in length, and flows northeast out of the Barrier Ranges in far western NSW. A map of the river has been made using 1:50,000 scale aerial photographs. The creek has been divided into three sections: catchment, trunk, and distributary fan; and other river and floodplain features have been interpreted. In 1997 and 1998 I established sites every one or two kilometers along the creek, and at each site surveyed a channel cross section, observed geomorphological relationships, and collected channel and bank sediment for description.

This research is being conducted on a half-time basis and will be completed in early 2002.