1999 Fowlers Gap Research Report

Events and outcomes of Open Day 1999
Reporter: Ben Macdonald, School of Geography, UNSW

The School of Geography organised an Open Day at the Fowler's Gap Field Station on July 16th 1999, and the venue was the shearing shed. A selection of the papers has been published in volume 21 of the Rangeland Journal and these reflect the wide nature of research at Fowler's Gap. It was the organiser's intention to invite papers from a wide field to highlight the varied research at the Station and provide cross-disciplinary discussion. Some of the papers are not specifically based at Fowler's Gap but all of the researchers have started their original research at the Station and have applied it to a broader area. The theme of the Open Day was "the understanding and application of sustainable use of rangeland resources in Australia". A key objective was to promote the research at the Station to the local graziers and landholders because it is the users and inhabitants of the rangelands who need the rangeland management information to care for the land.

The Open Day was very successful. It drew approximately 130 people from the surrounding area, including a student group from each of the University of New South Wales and Monash University, various government departments, graziers and other interested landholders. Question time after the presentations was always stimulating and there was a large exchange of information between participants, which is typically sadly lacking at other conferences. Quality and variety of the papers presented at the symposium and the selected papers published in the Rangeland Journal show that the University of New South Wales Fowler's Gap Research Station is still a cornerstone in rangeland research. This proves that the academics and administrators who believe that there is no more scope for research at Fowler's Gap are well wide of the mark.

Determinants of Reproductive Success in female Red Kangaroos.
Investigators: Amanda Bilton and David Croft, School of Biological Science, UNSW

Essential for effective population management is knowledge of the factors that affect female reproductive success and subsequently the recruitment of offspring to the next generation. Currently, the Red Kangaroo is subject to a commercial harvest (15-30% of the population), the management of which fails to take into account the current over-hunting of certain age/sex classes (up to 80% male), and the effect of adverse environmental conditions on specific age/sex classes. By examining the level and causes of variation in reproductive success among these animals, this project will provide a more comprehensive understanding of population composition and dynamics, and the application of the results to kangaroo management will be vital to the process of ensuring the sustainable harvest of this species.

Specifically I am looking to 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.

Results so far suggest that environmental conditions, in particular, rainfall and the abundance of good quality feed, in this case green grass, have a significant impact on the survival of young to weaning. It was found that those females that successfully reared their offspring to weaning were doing so at times when the amount of green grass available in the habitat, and the rainfall over that period, was significantly higher than for those females that lost their offspring. Given the highly dependant relationship between rainfall and plant growth in the semi-arid regions of Australia, and the high energy and nutrient requirements of growing young, it fits that the survival of the young is greatest during times of relatively good pasture conditions.

Sex of the offspring also seems to play an important role in the scheduling of maternal reproductive effort. Those mothers weaning male offspring were significantly older than those weaning female offspring, a life-history trait also observed in the Eastern Grey Kangaroo. Also, those mothers successful at rearing male offspring to the stage of permanent pouch exit, 8 months, were doing so at times when there was significantly more green grass available in the habitat compared to those mothers rearing females. These results suggest that females may manipulate their investment in male or female offspring according to the relative costs and benefits of rearing the different sexes. Continuing work on maternal care and behaviour will hopefully elucidate to what degree the sex of a mother's young may affect her life-time reproductive success.

Field work began in March 1998 and is due for completion by March 2001.

Feeding ecology, nesting behaviour and nest-site selection of the wedge-tailed eagle.
Investigators: Lisa Collins and David Croft, School of Biological Science, UNSW

An Honours thesis was produced from the research in 1999 under the title ' Factors influencing chick survival in the Wedge-tailed eagle, Aquila audax' with the following abstract.

Offspring survival is an important part of the population dynamics of every species. Chick survivorship in the wedge-tailed eagle, Aquila audax, was studied with reference to nest quality and parental quality. Nest quality included nest and tree characteristics, nest location with regard to local prey densities and the nest environment with regard to adverse sibling interactions. Parental quality included the proportion of time the parents were present at the nest and the behaviours they performed as well as the quantity of food presented to the chick and the composition of the chicks diet. The study site was at Fowlers Gap Arid Zone Research station in north-western New South Wales. Five nests were monitored with three out of the seven chicks known to hatch surviving to fledge. Nest and tree characteristics did not appear to influence chick survivorship. Prey surveys were performed every month over the study period and sightability of prey items was tested between nest sites by ANOVA with no difference found. Rabbit warrens were surveyed intensively to a 200 m radius around each nest and their abundance calculated by the regression equation y=0.707+0.355x. The abundance of prey animals was analysed by ANOVA with respect to nest success and the time at which the transects took place. No significant effect was found. Parental care-giving behaviours decreased with increasing age of the chick as did the amount of time a parent was at the nest relating to an increasing ability of the chick to thermoregulate and feed itself.

Bearded dragons were the main prey item delivered and fed to the chicks. The number of feeds given by the parent decreased with chick age and was found to correlate with the number of feeds of bearded dragon. Siblicide caused the death of one chick while another died due to infanticide. In another nest one chick fell out and the other died from unknown causes overnight. The failure of the unsuccessful nests early in the study resulted in a lack of data on parental behaviour for these nests leaving only the prey surveys and nest characteristics to be compared.

Further monitoring of fledging success in these eagles will be undertaken in 2000.

Red kangaroos and Eastern Grey Kangaroos in the arid rangelands: Factors impacting on water use

Investigators: Terence Dawson, Kirsten McTavish, Adam Munn, Joanne Holloway and Beverley Ellis, School of Biological Science, UNSW

Red kangaroos (Macropus rufus) occur widely in deserts and arid rangelands. Eastern grey kangaroos (M. giganteus) are a more mesic species but have spread into the arid rangelands in the past decades. Additional stock watering sites are suggested to have facilitated this movement. We examined the impact of environment, behaviour and diet on field water use by M. rufus and M. giganteus at Fowlers Gap Arid Zone Research Station in western NSW. The time was late summer and during the study the weather was fine and clear, with mean daily maximum Ta being 31 °C (range, 29-33 °C) and mean daily minimum Ta being 18 °C (range, 14-21 °C).

M. giganteus had marginally higher water turnovers (72 ml/kg.d against 58 ml/kg.d); however, they drank much more frequently than M. rufus. Differences between the species were also found in urine concentrations. Patterns of behaviour and diet selection were also noted. Although a specific reason could not be given for the higher water use of eastern grey kangaroos, the provision of additional stock watering sites likely facilitated their spread into the arid rangelands.

Publications

Blaney, C.E., Dawson, T.J., McCarron, H.C.K., Buffenstein, R. and Krockenberger, A.K. (2000) Water metabolism and renal function and structure in eastern grey kangaroos (Macropus giganteus): responses to water deprivation. Aust. J. Zool. (in review)

Dawson, T.J., Blaney, C.E., Munn, A.J., Krockenberger, A. and Maloney, S.K. (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). Physiol Zool. (in press).

Vegetation, hydrology, and erosion mechanisms in arid zone streams and shrublands

Investigators: David Dunkerley
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During 1999, field experiments dealing with the fate of rainwater in arid shrublands were continued. Additionally, opportunistic observations were made of flow and sediment transport in Homestead Creek and Fowlers Creek during flood events. The fundamental goal of this work is to advance the understanding of the hydrologic response of dryland landscapes at a range of spatial scales. These range from the very local scale of a single grass tussock or chenopod shrub, to the response of mid-scale features like the patchy distributions of plants, gibbers, and bare soil that is common in drylands, to the aggregated response of whole river catchments.

The vegetation mosaics of the Fowlers Gap and Broken Hill area were further explored using the cellular automata modelling approach (Dunkerley 1999a). This work has suggested that plant communities of this kind are relatively robust in the face of the stresses imposed by drought and by the marked variability of rainfall that occurs over parts of Australia strongly affected by the El Niño - Southern Oscillation (ENSO) phenomena (Dunkerley 1999b). The hydrologic and erosional processes that arise in these patchy landscapes have proven to be complex. The distributions of vascular and microphytic plants are in the form of complex mosaics. Additionally, however, there are associated variations in the properties of soils, and of the surface across which any runoff has to flow (Dunkerley and Brown 1999a). Furthermore, the hydrologic response of these plant communities is further complicated by the relatively little-known losses of water to canopy interception on the leaves and stems of the plants (Dunkerley and Booth 1999).

One of the landscape features that is unevenly distributed, and which is critical to the operation of many hydrologic and erosional processes is plant litter. The distribution of litter follows quite closely the distribution of shrubs and grasses. However, litter particles float, and are consequently easily swept through the landscape by even shallow surface runoff, especially on bare surfaces. During movement, plant litter often lodges against stems or on other obstacles to form litter barriers. These small and ephemeral features are nonetheless significant for the trapping of eroded soil, litter, dung, and seeds that they induce. The distribution of litter in turn influences the locations at which plant nutrients are returned to the soil as the organic materials decompose. Laboratory experiments using litter collected from Fowlers Gap have shown that one way in which litter is dispersed from a point source such as a chenopod shrub is by splash as raindrops, or water dripping from the plant itself, strike the soil surface (Geddes and Dunkerley 1999). The soil extending for some metres around such a plant receives the distributed organic matter, and this contributes to the properties of these soils, including an enhanced ability to take in rain and surface runoff water, so increasing the availability of the water in the plant root zone, as described in research mentioned in last year's Annual Report.

Once water and sediment enter rills and small gullies, they rapidly drain to local streams. Observations made during and immediately after a small flood in Homestead Creek have shown some unexpected results (Dunkerley and Brown 1999b). In particular, it was found that the concentration of eroded soil particles was greatest in the very first arriving flood water,

even after it had travelled many kilometres along the stream. Indeed, both the concentration of soil particles and their size declined in water following the flood front, in a very regular way that was related to the logarithm of the time elapsed since the flow-front had passed. Ordinarily, the highest sediment concentrations are expected to be associated with the highest water flow rates, which normally develop quite some time after the shallow flood front has passed. Study of the Homestead Creek flood, and its fate once it spilled into Fowlers Creek, suggested that the seepage of water into the sandy bed (called transmission loss) is relatively large in small flood events. It appears (but more work is needed to confirm) that transmission losses may fall to a minimum for floods that just fill the channel to the top of the banks, and then increase once more for even larger floods that spill out onto the surrounding landscape. If this is so, then it provides a link to the importance of 'bankfull' flows that has been recognised from humid zone streams for a long time.

Publications:

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Dunkerley D.L. 1999 (b). Banded shrublands of arid western N.S.W.: responses to interannual rainfall variability. Ecological Modelling 121: 127-138.

Dunkerley D.L. & Brown K.J. 1999 (a). Banded vegetation near Broken Hill, Australia: significance of soil surface roughness and soil physical properties. Catena 37: 75-88.

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Dunkerley D.L. & Booth T.L. 1999. Plant canopy interception and its significance in a banded landscape, arid western New South Wales, Australia. Water Resources Research 35(5): 1581-1586.

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The Western NSW Archaeological program (WNSWAP) at Fowlers Gap

Investigators: Trish Fanning[1] and Simon Holdaway[2]
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Support: Australian Research Council Large Grant

The Western New South Wales Archaeological Program (WNSWAP) was initiated in 1995 to investigate Aboriginal stone artefact scatters and associated features, such as ovens, in a landscape context. The first four field seasons were spent at Mt Wood in Sturt National Park,

developing techniques based around the close integration of archaeological and geomorphological data sets using electronic survey technology and Geographic Information System (GIS) software. This initial research established methods for accurately locating and recording thousands of artefacts exposed by erosion across tens of thousands of square meters of landsurface. Differential visibility and size sorting of artefacts was controlled for through a combination of techniques: refitting, analysis of artefact dimensions with slope and analysis of artefact size with depositional environment. Having thus taken account of the post-discard history of the artefacts, we have analysed their spatial distribution to determine at what scale behaviourally meaningful clusters of artefacts can be recognised. A temporal framework for these investigations was provided by radiocarbon dating of charcoal from the remains of ovens, and stratigraphic analysis and dating of the alluvial valley fills.

At Fowlers Gap, we are applying the results of this research to investigate the Late Holocene archaeological record in one location with a variety of landscape types as a way of assessing variation in Aboriginal occupation intensity, mobility and resource use. Following reconnaissance in April, we chose for detailed investigation, six land systems containing extensive lagged surfaces with high artefact visibility. Pilot surveys in each of these, carried out in June, focussed on assessing the variation in artefact density, degree of clustering and the nature of assemblage composition between land systems. We will use this information to determine the sizes of randomly selected sample sites within each land system which need to be surveyed in the next two years. We have also located and assessed the condition of around 500 ovens, a sample of which we hope to excavate and date in the next two years.

While our project is still in its early stages, it is already clear that stone artefacts are neither randomly nor uniformly distributed across the landscape. Rather, they are clustered in different ways in each of the land systems investigated, reflecting the different ways in which Aboriginal people interacted with the varied landscape in the past.

Using In-Situ-Produced Cosmogenic Isotopes to Understand the Formation of Stone Pavements and Aeolian Deposited Soils at Fowlers Gap, North Western New South Wales.

Investigator: A.G. Fisher[1], B.C.T. Macdonald[1], M.D. Melville[1], J. Chappell[2] and D. Fink[3]
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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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The effect of sheep grazing on lizard assemblages in the NSW arid zone.

Investigators: Elizabeth Magarey and David Croft , School of Biological Science, UNSW

An Honours thesis from the research was produced in 1999 under the title 'The effect sheep grazing on lizard assemblages in the New South Wales arid zone' with the following abstract.

This study investigated the effect of sheep grazing on the diversity, composition and relative abundance of lizard species, in two vegetation communities, in the New South Wales and rangelands. Pitfall trapping was used to estimate the relative abundance of species in grazed areas, compared to areas that have remained free of sheep for over forty years.

Over the three seasons sampled, only one lizard species, Ctenotus schomburgkii, was identified as significantly affected by sheep grazing, having a lower abundance in grazed mulga woodland sites. There was no difference in species diversity or richness between stocked and unstocked areas.

Multi-dimensional scaling and correspondence analysis revealed that individual sites responded differently to stocking, and that the effect on lizard species was intimately dependent on these habitat changes. Only where grazing resulted in a decrease in the volume of large perennial shrubs, and a change in floristic composition of the canopy, did the lizard assemblage change in composition. Where the structure and floristic composition of the vegetation remained similar across grazed and ungrazed sites, the common lizard species were unaffected.

The distribution of specific floristic/edaphic associations was the primary determinant of lizard assemblage structure in this study. The high degree of habitat partitioning demonstrated here no doubt contributes to maintenance of the high species diversity that is characteristic in the New South Wales and zone.

Further research is planned in relation to sheep-induced piospheres for comparison with ongoing research in Sturt National Park.

Digestive limitations and maintenance energy and nitrogen requirements of juvenile red kangaroos (Macropus rufus)

Investigator: Adam Munn and Terence J. Dawson, School of Biological Science, UNSW, Sydney, NSW 2052

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). Using animals obtained from Fowlers Gap, work conducted at the university of New South Wales Kensington campus indicates that juvenile red kangaroos have basic energy and water requirements far greater than expected for an animal of there size, and considerably higher than those of adult red kangaroos. To examine the ecological implications of this, a study of the digestive constraints and maintenance requirements of juvenile kangaroos is currently under way. Preliminary results show that the ability of juvenile kangaroos to digest poor quality, high fibre feed is somewhat lower than that of adults. Under drought conditions, when only poor quality feed is available, the digestive limitations and high demands of juveniles no doubt contribute to the high rates of juvenile mortality observed. Further, information from this study and will be used in developing and testing foraging models at Fowlers Gap.

Acquisition and analysis of rainfall data from Fowlers Gap

Investigators: Jim Tilley and Alf Wojcik, School of Civil and Environmental Engineering, UNSW

In early February 1999, Jim Tilley visited Fowlers Gap and re-open edfour of the old Water Engineering rainfall recording sites on the Station. These sites, along with the rest of the Water Engineering sites (11 Pluviometer and runoff plot sites as well as 6 water storage recording sites) were all closed in 1988-89. The old sites were all strip chart recorder instruments and were labour intensive requiring two man-days per week to service the network. The rainfall sites that were reopened are at Sandstone West (the old Frieslich Mort site), Nelia III plot site, Mating large plot site and the North Mandleman large plot site. While it would be preferable to have a much denser network of rainfall sites these ones were chosen to give a north/south, east/west cross sectional representation of the Station as a starting point.

The four instruments installed are tipping bucket rain gauges complete with data loggers. These instruments can be visited a few times a year to check on their operation and retrieve data after events as required. The data loggers record the exact time and date of every tip of the bucket of known quantity. At present station staff remove the loggers and replace them with units posted out from Kensington and return the used units to Kensington to download and disseminate the data. The data is stored in the School's large HYDSYS time series database and can be accessed from there to forward to the station for on site records or to others on campus as required. The data is available electronically for insertion into spreadsheets etc. or as hard copy graphs etc. directly from HYDSYS.

To date approximately 18 months of data has been logged, much of which is available by contacting Mr. Alf Wojcik, P.O. at the School of Civil and Environmental Engineering, (02) 9385 5025, 0415 271 723, or a.wojcik@unsw.edu.au. Future plans include submission of quotations, to the management committee, for a complete compact weather station to be installed at the site of the old homestead weather station. This would use a data logger on site connected, if required, to a PC in the office for instant read outs and/or alarm conditions. Technology has moved a long way in the last decade or so such that the current cost of a state of the art, simple to operate, weather station is now only a fraction of the cost of the original weather station installed in the early 1980's. Likewise telemetry is now another real option to be investigated that would be capable of connecting all the outlying sites to the same system.