Creating and enhancing green spots in the arid zone of western NSW, Australia

Theakston, P[1]; Dohnt, B[2]

[1] Western Local Land Services - NSW Government, Cobar, NSW, Australia; [2] Western Local Land Services - NSW Government, Cobar, NSW, Australia

Key words: green spots; rangeland rehabilitation; habitat

Abstract

Arid zone biodiversity adheres to a boom-bust cycle. During periods of ample surface water and vegetation, species reproduce quickly and spread across the landscape (boom period). In contrast, during extended dry periods (bust period), species numbers decline and retreat to locations that remain moist, called "green spots". Green spots vary in size and extent, from individual landscape features, such as gilgais, ephemeral wetlands and creek line waterholes to extensive healthy floodplains.

Widespread degradation occurred in the arid zone of western NSW between the period of the 1890s to the late 1940s, creating legacy erosion issues. Present day degradation occurs to a lesser degree, which impacts on green spots, reducing their size and extent.

This project created and/or enhanced green spots on six pastoral properties in arid western NSW, creating a total of 37 localised green spots and rehydrating 850 ha of floodplain. Rangeland rehabilitation earthworks were used in an expanded way to create more persistent green spots, rather than solely for groundcover establishment for pastoralism.

Introduction

The arid zone of western New South Wales (NSW) experiences periods of substantial surface water and vegetation, separated by very dry conditions of irregular length and severity. Surface water and vegetation become increasingly rare as dry conditions prevail. The areas that remain moist within this vast and dry landscape are called green spots. Green spots vary in size and extent, from individual landscape features, such as gilgais, ephemeral wetlands and creek line waterholes to extensive healthy floodplains. Relictual populations of native animals become reliant on green spots as the dry period progresses (Woinarski 1992) competing with domestic livestock who also rely on these areas. The unpredictable nature of the boom and bust cycle can have severe consequences for the quality and extent of green spots.

Widespread degradation occurred in western NSW between the period of the 1890s to the 1940s (Condon 2002a). For example, during the 1940s drought, Beadle (undated) recorded creek line waterholes,

previously 20 feet deep, filled with sediment due to accelerated erosion in the hinterland. Present day degradation occurs to a lesser extent and severity (Condon 2002b) with causes being: livestock grazing behaviour (Pringle and Landsberg 2004); excessive total grazing pressure and infrastructure development (Pringle et al. 2011) and historic over-stocking causing legacy erosion (Fanning 1994). These factors potentially cause the destruction of green spots by the erosional process described by Pringle (2006).

The erosional process starts with increased runoff due to lack of groundcover combined with nickpoint development. A nickpoint is an incision on the natural land surface where flows concentrate resulting in increased erosive power. Causes of nickpoint formation are varied, some examples are: cattle paths lowering the outlet sill of a wetland, "unplugging" the wetland; or a farm track cut into natural ground level which channelises flows. Nickpoints can develop into headcuts, where water falls over a vertical face causing undercutting and collapse of the wall. A headcut progresses upslope, along the path of strongest flow, resulting in gully erosion. These flow paths are the green spot areas, and once a headcut expands through them, they disappear and are replaced with a dryland system (Pringle 2020). This erosional process can occur quickly, with headcut retreat rates of up to 32 metres per annum being measured in western NSW (Graves et al. 2024).

Western Local Land Services (WLLS) implemented a project in 2023 to create and enhance green spots on six pastoral properties in the arid zone of western NSW. WLLS is a government agency concerned with improving both agricultural productivity and management of natural resources. WLLS has experience in implementing arid rangeland rehabilitation works, the primary purpose of which is to control erosion and establish groundcover for pastoralism (Green 1989). This project sought to expand the use of these rehabilitation techniques to include environmental/biodiversity outcomes through creating longer lasting refugia while controlling erosion and improving groundcover.

Methods

Funding provided by the Environmental Trust of NSW enabled projects to be undertaken on six pastoral properties in western NSW (NSW Environmental Trust 2024). Participants were identified based on previous involvement with rehabilitation projects and capacity to deliver.

Project areas were chosen in collaboration with land managers and were either existing green spots that were being threatened by gully expansion or previous green spots that had been severely degraded.

Green spots can be either localised or extensive. To create localised green spots, a dimensional approximate definition was formed based on existing, healthy green spots in the project areas. A green spot was defined for this project as a depression that holds water for at least one month, with a minimum depth of 0.5m and a minimum area of $50m^2$, keeping the surrounding vegetation green for longer. Extensive green spots are healthy floodplains which hold water after flows have ceased. In this project, perched floodplains, which no longer receive floodwater due to dewatering caused by gully headcuts, were rehydrated, creating extensive green spots.

Design and layout of projects incorporates a drainage ecosystem perspective, creating and/or enhancing green spots in appropriate locations (Tinley and Pringle 2014a; 2014b) using heavy earthmoving machinery to construct earthen banks. A range of techniques were used, which included check banks, diversion banks, champagne banks, water ponding (Harrison 1994; Quilty 1972a,b; Rhodes 1987) and variations of these techniques based on the author's experience and practice (Theakston and Anderson 2023).

Results

Over the six projects, 37 localised green spots were created in the form of wetlands/waterholes which met the defined minimum dimensions of 0.5m depth and 50m^2, and approximately 850 ha of perched and degraded floodplain was also rehydrated.

Goodwood Station Green spot project

One example of creating localised green spots and rehydrating a floodplain to address legacy erosion occurred on Goodwood Station, owned and managed by Zane and Louise Turner. In western NSW, erosional processes were triggered by the introduction and mismanagement of domestic stock over 140 years ago (Fanning 1999) and current land managers are largely dealing with the resulting erosion.

The project area is a valley side, supporting banded chenopod vegetation with contour patterned small ephemeral waterholes, locally known as gilgais. Apart from the contour-patterned gilgais, the area also has a cluster of relatively deep gilgais (up to 0.8 metres deep) covering 3 hectares, creating a healthy green spot (photo c). Shallow, sinuous drainage lines dissect the area and in their uneroded state contain ephemeral waterholes upheld by sediment sills, forming corridors of green spots (Pringle &Tinley 2003). However, in the current state, instead of shallow sinuous channels, the drainage lines are erosion gullies (photo b) due to firmly established erosional processes as described by Pringle (2006). Any green spots that may have existed along the drainage lines have disappeared due to channel incision and headcut retreat "unplugging" moist areas. Furthermore, the gully is widening due to bank undercutting and collapse and expanding due to lateral gullies, with retreating headcuts threatening to dewater the cluster of deep and healthy gilgais.

The cluster of deep gilgais was an isolated green spot, separated by 1.6 kms from the closest other healthy green spot, located in the valley floor creek line. This creek line contains numerous waterholes up to 1.0 metres deep once creek flows cease (photo a). The project involved creating a corridor of 16 localised green spots connecting the valley floor waterholes with the cluster of deep gilgais. At the same time, re-hydrating 80 ha of a narrow floodplain along the shallow drainage line, recreating sinuous flow.

The average distance between the re-created green spots is 192 metres (83m–410m). The section of the drainage line with the larger gap of 410 metres was healthier and less incised, therefore it was considered not necessary to re-create any green spots along this length.

A total of 7,450 metres of banks were constructed, including large check banks combined with diversion banks intersecting the incised drainage line (shown on figure 1). These are larger banks of 1.0 metre high with a base width of 5.0 metres. Water ponding and champagne banks were constructed (not shown in Figure 1 for sake of simplicity) to rehydrate the narrow surrounding floodplain. Champagne banks are short diversion banks (<100 metres long) which direct flows away from incised drainage lines. They spill the flows from one bank to the other, spreading the water away until a safe re-entry point is found into the drainage line, whilst creating sinuous flow.

The earthworks for the green spot projects were only recently completed, so there is not yet evidence of groundcover and biomass responding positively. However, based on a recent study looking at water ponding in similar landscapes and climates, it is expected that the landscape treated in this project will respond in similar positive ways. In this study, the highest average biomass for ponded sites was 2161 (+- 650) kg/ha, compared to the control area of 254 (+-54) kg/ha (McDonald et al. 2022). Similar results are expected for the water ponding areas within the green spot projects given sufficient rainfall and time.

Discussion

Arid rangeland rehabilitation works have traditionally focused on improving ground cover and vegetative biomass. To achieve maximum groundcover and biomass, the ideal water ponding depth is established at 10 cm. Deeper ponding depths cause waterlogging of soil and encourage the growth of water adapted plants not suitable for pastoralism (Rhodes 1987). This project intentionally increased ponding depth to a minimum of 0.5 metres to encourage water adapted plants and provide longer lasting surface water to create a more diverse habitat.

The design of the green spot projects also includes water ponding banks and diversion banks that pond shallow water (less than 10cm) to improve groundcover and biomass, which is especially suited to pastoralism. This project expands the potential of arid rangeland rehabilitation works to include not only groundcover establishment for pastoralism, but also creation of longer lasting green spots to provide habitat for small native mammals.

The longer lasting green spots have been created in degraded, incised drainage lines. The incised line is up to 1 metre lower than the natural land surface and by constructing a check bank across the incised line, a pond is formed, which becomes the green spot. The check bank with its corresponding diversion bank directs flows onto the adjacent floodplain which rehydrates the area and creates sinuous flows. The actively eroding features can be used to create positive environmental outcomes alongside pastoralism.

Green spot destruction is a major cause of arid small mammal decline (Morton 1990), and by expanding the use of arid rangeland rehabilitation works to address environmental goals, in addition to pastoral goals, it is possible to create and increase suitable habitat to support arid small mammal populations. The distance between re-created green spots should be such that arid small mammals can travel. Frank and Soderquist (2005) recorded a Stripe-Faced Dunnart (*Sminthopsis macroura*) covering 300 metres in one night and Moseby and Read (1998) recorded Bolam's Mice (*Pseudomys bolami*) moving on average 187 metres (110m-374) in a few hours, utilising burrows or shelters. It is considered by ecologist that 200 metres is within the travel range of most arid small mammals (James Val, pers. comment). These travel distances serve as a guide to the distance between re-created green spots, especially if the object is to extend the range of suitable habitat.

WLLS will be conducting fauna monitoring on these projects to determine whether small mammals find and utilise the newly created habitat.

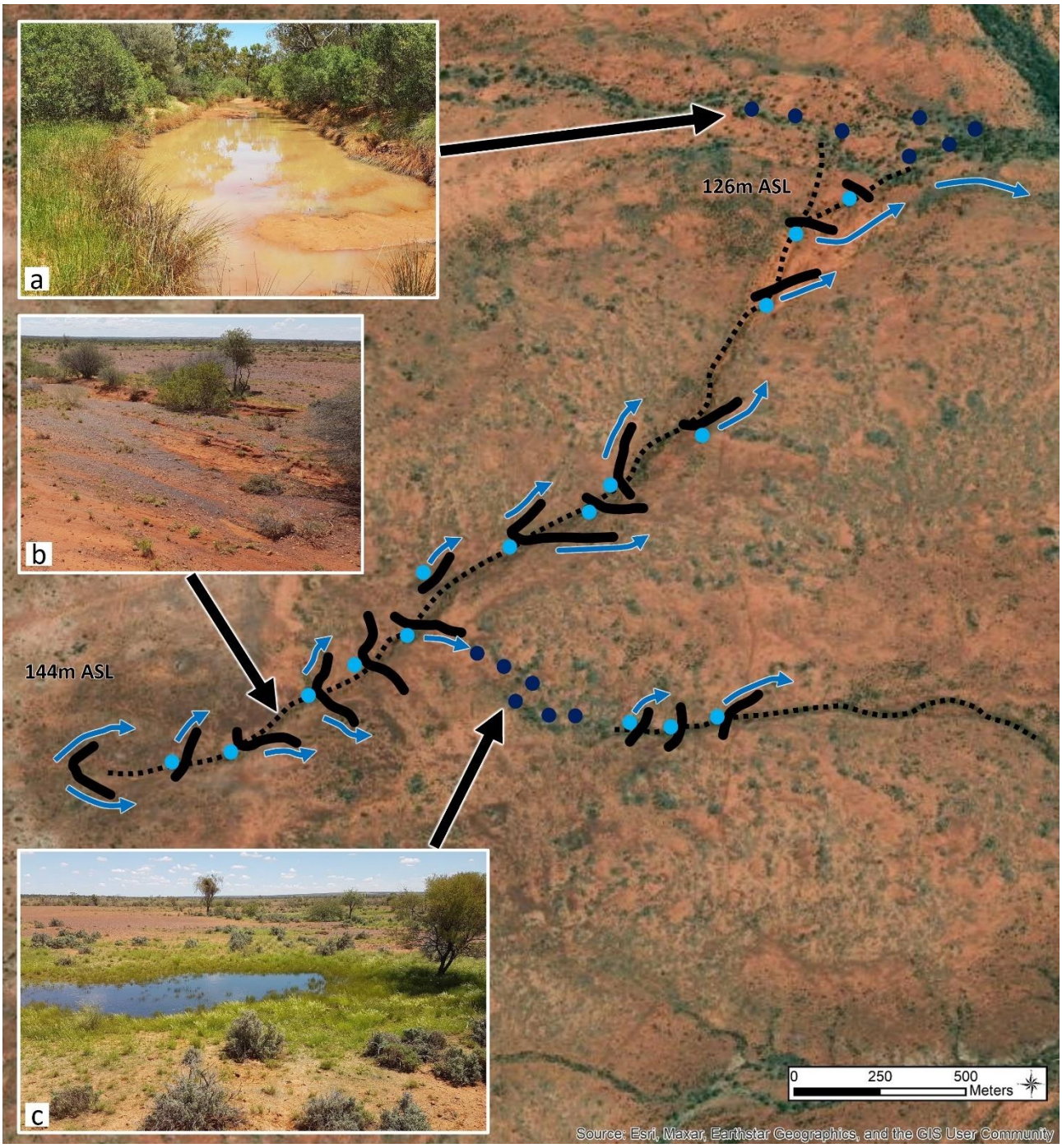

Figure 1: Simplified layout of Goodwood green spot project. Solid black lines represent check banks combined with diversion banks which pond water in the incised gully, creating localised green spots, then release flows onto surrounding floodplain. Dotted line represents incised gully. Blue arrows represent flows. Dark blue points represent existing, healthy green spots. Light blue points represent re-created green spots, creating a corridor of green spots. photo a) creek line waterholes. photo b) incised drainage line. photo c) cluster of deep gilgais.

Acknowledgements
Funding for this project was provided by the Environmental Trust of NSW.

References

Beadle NCW (undated) An Erosion Survey of the Western Division of New South Wales 1940-1945 - Report A12. Soil Conservation Service of NSW, unpublished report, Sydney, NSW.

Condon D (2002a) The bleeding heart, land condition in the first half of the twentieth century. In 'Out of the West, A Historical Perspective of the Western Division of New South Wales', (Rangeland Management Action Plan)

Condon D (2002b) The reasons behind the recovery – and a look into the future. In 'Out of the West, A Historical Perspective of the Western Division of New South Wales', (Rangeland Management Action Plan)

Fanning P (1994) Long-term contemporary erosion rates in an arid rangelands environment in western New South Wales, Australia. *Journal of Arid Environments* 28, 173-187.

Fanning P (1999) Recent landscape history in arid western New South Wales, Australia: a model for regional change. G*eomorphology* 29, 191-209.

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

Graves BP, Ralph TJ, Helander C, Gore DB (2024) Patterns and processes of channel and floodout adjustment in a discontinuous dryland river, semi-arid eastern Australia. *Geomorphology* 446, 109004.

Green DR (1989) Rangeland restoration projects in western New South Wales. *Australian Rangeland Journal,* 11(2), 110-116.

Harrison P (1994) Ponding Banks, Water Spreading and Similar Rangeland Interventions and their use in Central Australia. Rangeland Management Section, Alice Springs, NT.

McDonald S, Orgill S, Andersson K, Beange L, Toole I (2022) Benefits of Rangeland Rehydration Works for Soil, Vegetation and Landscape Function in Western NSW. Department of Regional NSW.

Morton SR (1990) The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. *Proc. Ecol. Soc. Australia* 16, 201-213.

Moseby KE & Read JL (1998) Population dynamics and movement patterns of Bolam's mouse, *Pseudomys bolami*, at Roxby Downs, South Australia. *Australian Mammalogy* 20, 353-368.

NSW Environmental Trust (2024) available at https://www2.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust [accessed 29 11 2024].

Pringle HJR & Tinley KL (2003) Are we overlooking critical geomorphic determinants of landscape change in Australian rangelands? *Ecological Management and Restoration* 4, 180-186.

Pringle HJR & Landsberg J (2004) Predicting the distribution of livestock grazing pressure in rangelands. *Austral Ecology* 29, 31-39.

Pringle HJR, Watson IW, Tinley KL (2006) Landscape improvement, or ongoing degradation – reconciling apparent contradictions from the arid rangelands of Western Australia. *Landscape Ecology* 21, 1267-1279.

Pringle H, Zimmerman I, Tinley K (2011) Accelerating Landscape Incision and the Downward Spiralling Rain Use Efficiency of Namibian Rangelands. *Agricola* 43-52.

Pringle H (2020) Is gully expansion a major issue for key biodiversity values in arid lands? *Grassroots* 20, 3-6.

Quilty JA (1972a) Soil conservation structures for marginal arable areas: gap absorption and gap spreader banks. *Journal of the Soil Conservation Service of New South Wales* 28(3), 115-129.

Quilty JA (1972b) Soil conservation structures for marginal arable areas: diversion spreader banks and tank drains. *Journal of the Soil Conservation Service of New South Wales* 28(4), 157-168.

Rhodes DW (1987) Vegetation Response and Productivity Improvements Under Water ponding. *Journal of the Soil Conservation Service of New South Wales* 43, 62-67.

Theakston P & Anderson C (2023) Considering Geomorphic Processes in Rangeland Rehabilitation Works. In 'Proceedings 22nd Biennial Australian Rangeland Society Conference'. 60. (ARS: Broome, WA, Australia)

Tinley KL & Pringle HJR (2014a) *Rangeland Rehydration: 1. Field Guide*. Rangelands NRM, Western Australia.

Tinley KL & Pringle HJR (2014b) *Rangeland Rehydration: 2. The Manual*. Rangelands NRM, Western Australia.

Woinarski JCZ, Whitehead PJ, Bowman DMJS, Russell-Smith J (1992) Conservation of mobile species in a variable environment: the problem of reserve design in the Northern Territory, Australia. *Global Ecology and Biogeography Letters* 2, 1-10.