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Restoring biodiversity in a multi-use rangeland: mining, pastoral and Indigenous land users come together at Arid Recovery, South Australia

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Abstract

Australia's arid rangelands have suffered record losses in biodiversity since European colonisation, especially for mammalian fauna, principally driven by invasive species. The scale of the challenge to restore biodiversity requires long-term multi-stakeholder partnerships. Arid Recovery is an independent NGO in the dry rangelands of South Australia, and a unique partnership between the mining industry, government, Indigenous groups, rangeland communities and pastoralists. Work centres around a large predator-proof fenced reserve (12,300 ha) where rabbits, cats and foxes have been removed and six threatened native species have been reintroduced. The reserve supports a robust conservation science program that includes developing tools for management of introduced species, reintroduction of threatened species, and approaches to restore biodiversity at scale. We share lessons from 28 years of rangeland ecosystem restoration and research.

Introduction

While arid and semi-arid ecosystems have had less vegetation clearance than other habitats in Australia since European colonisation, the arid and semi-arid rangelands have suffered record losses in biodiversity due largely to invasive species (Dickman and Pavey 2023). The introduction of rabbits (Oryctolagus cuniculus), cats (Felis catus) and foxes (Vulpes vulpes) has transformed rangeland ecosystems. The spread of rabbits has caused long-term damage to rangeland vegetation (Finlayson et al. 2022), exacerbated by livestock grazing and feral herbivores (Silcock and Fensham 2013). Rabbit populations support the persistence of invasive predators (Read and Bowen 2001), which in turn are the primary cause of the loss of two thirds of the mammal fauna in the rangelands (Woinarski et al. 2019). Of these losses, around half the affected mammal species are now extinct, while another half suffered dramatic range contractions, many of them only surviving on islands free of cats and foxes (Legge et al. 2018). There have also been impacts to other fauna and flora, with some bird and reptile species made locally extinct or rare and vegetation communities altered by grazing (McLellan and Watson 2022; Read and Cunningham 2010). Here we report on a long-term collaboration by diverse land users, institutions and communities to restore biodiversity in Australia's arid rangelands. We highlight some of the challenges faced and knowledge generated over 28 years of applied research.

Methods

Arid Recovery is an independent partnership between the mining industry, government, academia and the conservation sector, in collaboration with Indigenous groups, pastoralists and rangeland communities. The initiative started in 1997 when co-founders sought to take advantage of the transformational reduction in rabbits, cats and foxes numbers caused by rabbit haemorrhagic disease (Pedler et al. 2016) to permanently exclude rabbits from an area of outback South Australia to allow native vegetation to recover, while also excluding cats and foxes to enable the return of vulnerable native animals (Moseby et al. 2018). A cost-effective exclusion fence was designed and tested (Moseby and Read 2006). The reserve grew to six paddocks over 12,300 hectares. Foxes are excluded from all, rabbits have been removed from four paddocks (6,000 ha) and cats have been removed from five (8,600 ha) but allowed to remain in the sixth for experimental purposes. Five locally extinct threatened native species have been successfully reintroduced: burrowing bettongs *Bettongia lesueur*, greater bilbies *Macrotis lagotis*, Shark Bay bandicoots *Perameles bougainville*, western quolls *Dasyurus geoffroii* and kowaris *Dasyuroides byrnei*. A further three threatened species reintroductions were trialled but one failed (greater stick-nest rat *Leporillus conditor*) and two did not progress to full translocations due to predation by native predators (numbat *Myrmecobius fasciatus* and woma python *Aspidites ramsayi*). Two locally rare threatened species colonised the reserve and have sustained populations since: plains mice *Pseudomys australis* and thick-billed grasswrens *Amytornis modestus*. The reserve layout provides experimental power with different experimental treatments across paddocks. A rigorous science program is supported by an advisory panel and collaborations with over 80 different institutions.

Results and discussion

Total grazing pressure must be managed

Arid Recovery's original focus of ecosystem recovery through removing introduced herbivores (rabbits and livestock) was challenged when a reintroduced native herbivore became overabundant. Burrowing bettongs are generalist herbivores that, from a founding population of 29 animals in 1999, increased to an estimated population of 8,000 by 2016. This resulted in reduced cover of more palatable plants and damage to sensitive perennial vegetation (Linley et al. 2017; Moseby et al. 2018). Competition with bettongs for food contributed to the local extinction of stick-nest rats, combined with increased predation pressure by goannas and reintroduced western quolls and an extended drought and record breaking hot summer (Moseby et al. 2024). Management of an overabundant threatened species within the reserve presented challenges. Unlike livestock, there was no market to sell animals and nor could they be translocated in sufficient numbers due to the very limited locations where they could be safe from predation (Radford et al. 2018). Lethal control was contemplated, but made difficult by the status of the species affording it legal protection and risks to the organisation of overstepping social licence. Contraceptive measures were trialled but were not feasible at the scale required. Some animals were allowed to self-disperse through one-way gates out of the reserve into the surrounding area where predators were controlled but not excluded (Butler et al. 2019). These animals had poor survival and persistence due to insufficient control of cats and foxes outside (Moyses et al. 2020). Ultimately, a severe drought in 2018-19 caused the collapse of the bettong population as food resources dwindled (Moseby et al. 2024). Arid Recovery now works to thresholds (50-100 bettong tracks per km) to trigger management actions such as translocation or control based on total grazing pressure measures from vegetation condition measures and interventions described in an adaptive management framework.

Ecosystems need predators

The lack of sufficient predation pressure was the main driver for overpopulation of native herbivores so western quolls were reintroduced in 2018. Quolls are marsupial predators that once occurred across 70% of mainland Australia. In the first reintroduction to an arid ecosystem, 12 adults were released in 2018 following a successful trial. One of the reserve's six paddocks was designated as a control area from which quolls were to be excluded to i) maintain insurance populations of threatened prey species, ii) measure the impact of quolls on the ecosystem, and iii) maintain prey populations naïve to mammalian predators for research (Moseby et al. 2023). Maintaining

the control paddock presented a challenge, with at least one quoll incurring into the control paddock each year. Small quolls could gain access by squeezing through the 50mm aperture netting or exploit weak points at corners. However, with regular monitoring and response, quoll have consistently been removed and the control area's integrity maintained. Six years since the release of quolls, there is clear evidence of suppression of prey species and early evidence of trophic cascades (Stepkovitch et al. 2023). Bettong populations in quoll-occupied areas have been maintained below the acceptable thresholds, while bettongs in the quoll-free control paddock exceeded threshold in 2024, triggering translocation of animals out of the paddock. On a smaller scale, our experience reflects the major issue of overabundant kangaroos in the southern Australian rangelands, largely due to the absence of a predator, the dingo (Dawson et al. 2023).

Unique rangeland biodiversity must be preserved

Species restricted to arid ecosystems are dependent upon conservative rangeland management. An Australian example is the kowari, a small marsupial predator that occurs primarily on pastoral lease estate and exclusively so in South Australia. The species has a 20% risk of extinction within 20 years and was recently upgraded to the category of Endangered (Greenville et al. 2018). In 2022, 12 adult kowaris and their small dependent pouch young were translocated to Arid Recovery to establish an insurance population safe from predation by cats and foxes. The population has established and is being compared with remaining wild populations to understand causes for the kowari's decline and what management could be implemented on pastoral stations to improve its prospects. As climate change increases the frequency and intensity of droughts and heatwaves, arid species are in great need of large, interconnected protected areas under conservation management to buffer them against stochastic shocks.

Ecosystems operate across tenure

While using fencing to exclude threats is effective (Moseby et al. 2011), it is not a feasible tool for broadscale, sustained biodiversity recovery. This requires collaboration with diverse rangelands users because species and threats operate across property boundaries and tenures. The Arid Recovery Reserve presents an opportunity to seed the wider landscape with otherwise locally extinct species that have some tolerance to predation by introduced predators or may develop improved anti-predator traits through accelerated evolution (Ross et al. 2019). Effective control of cats and foxes will be necessary to elicit recovery beyond fences, especially as such reserves can attract predators like cats (McGregor et al. 2020). Another key challenge in recovering biodiversity in open landscapes is control of introduced predators in rangeland ecosystems where rabbits are present. We are pursuing the goal of leveraging the predator-free reserve to recover biodiversity in the wider Arid Recovery region in collaboration with Aboriginal communities, pastoral and mining partners. Feral predator control and monitoring of threatened species such as quolls has been coordinated with the Kokatha Aboriginal Corporation that manage three large pastoral leases around the reserve. Predator-proof safe havens like Arid Recovery are an essential bastion against extinction, but risk becoming a long-term holding pattern if efforts to recover biodiversity at scale in open landscapes are not pursued simultaneously (Read et al. 2023).

Conclusions

No rangeland system is immune to the risk of overgrazing. Earlier management of overpopulation could have prevented impacts to the Arid Recovery ecosystem from overpopulated bettongs. Native herbivores in reserves must be managed much as stocking rates for livestock during periods of scarcity in the rangelands. The return of the quoll is showing early signs of being an effective natural solution. Collaboration by different land users is essential to maintain and recover biodiversity in the rangelands as threats operate across tenures and protection of refugial areas for threatened species becomes more important under climate change. The broadscale coordinated control of feral predators required will only be possible through collaboration with a network of land managers over large areas. Equipping and energising rangeland communities for this work is essential, as is investing in research for 'beyond the fence' solutions and suitable policy for retaining the unique biodiversity of the Australian rangelands.

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