Science for Saving Species

Research findings factsheet

Project 2.4

Threatened Species Recovery Hub

National Environmental Science Programme

Degraded or just dusty? Examining ecological change in arid lands

In brief

European land management practices have been implicated in the degradation of the inland eastern Australian drylands over the past 150 years. However, little is known with certainty about the state of these rangelands before pastoralism began. We explored approaches to critically assess degradation in semi-arid and arid inland eastern Australia.

We used early explorer journals, long-term grazing exclosure experiments, surveys of rare and potentially grazing-sensitive plant species, and assessments of water-remote areas to investigate the extent of degradation in these drylands.

These regions are characterised by long dry spells broken by infrequent and unpredictable 'boom' events, and this adaption to natural extremes has largely conferred these areas with resilience in the face of the disruptions of pastoralism.

This resilience, however, has some important exceptions, and does not extend to the fate of mammals predated by feral cat and foxes in the study region or to spring-dependent plant and animal species. In addition, some palatable native perennial plants appear to not be regenerating and there has been invasion of prickly shrubs and buffel grass across some large areas, which has altered their ecosystem structure and function.

The findings provide new understanding of these regions and guidance for future conservation management.

Pastoral management since the 1830s is assumed to be responsible for degradation of large areas of inland eastern Australia. Image: Jaana Dielenberg

Context

The ecological history of arid and semi-arid lands, defined here as receiving less than 500 mm average annual rainfall, is often presented as a tale of devastation, where human management such as inappropriate land use and deforestation irreversibly degrade fragile ecosystems. In Australia, such "degradation narratives" include a perception that semi-arid and arid drylands are inherently fragile and vulnerable to exploitation, and that pastoralism since the 1830s has degraded these areas.

However, it is uncertain how to measure degradation, especially in such low-productivity environments characterised by extreme natural variability. In times of drought arid landscapes may display the hallmarks of degradation but recover rapidly after rain. Even dust storms, the archetypal symbol of degradation, are often natural occurrences in arid lands.

Understanding the ecology of these drylands and whether they truly are degraded, and in what ways, has important consequences for rangeland management programs, which are typically founded on presumptions of substantial and ongoing degradation from former 'natural' states.

The University Of Queensland AUSTRALIA

CSIRO

BRI Queensland Herbarium

What the research looked at

Given the difficulties in recognising and measuring degradation in arid lands, we explored four complementary approaches to critically assess degradation in semi-arid and arid inland eastern Australia:

1. the historical record (early explorer journals dating from the beginnings of pastoralism);
2. long-term grazing exclosures across four major arid zone land types (mulga shrubland; Mitchell grass downs; Channel Country floodplains; and low rolling dunefields);
3. systematic surveys for potentially rare and sensitive plant species; and
4. assessment of water-remote areas in relation to rare plant occurrence.

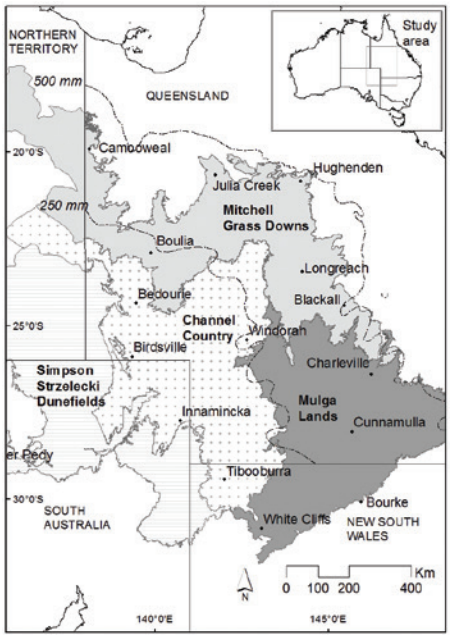
The inland eastern Australian drylands (here defined as that portion of Queensland, northern New South Wales, north-eastern South Australia and the eastern Northern Territory receiving less than 500 mm of average rainfall per year) form part of one of the largest desert systems in the world, and are subject to recurring arguments about the nature and extent of ecological change.

While relatively small parts of the study area are occupied by mining leases and conservation reserves, most of it is used for extensive cattle grazing and, in the eastern and southern parts, sheep grazing. Native herbivores (kangaroos and wallabies) are abundant, as are a suite of introduced feral herbivores: goats, rabbits and camels, horses, donkeys and pigs.

Based on a review of literature from the study area and arid lands globally, we formulated four hypotheses to detect degradation. If areas of inland eastern Australia are ecologically degraded, we predicted that:

Hypothesis 1. Evidence from the historical record would show that tree and shrub cover has increased, alongside a reduction in burning and changes in the density of native animals.

Hypothesis 2. The abundance of plant species will have changed under different management regimes, including unpalatable and annual species replacing palatable and perennial species in grazed areas, and an overall decline in plant species diversity.



Inland eastern Australia study area, showing state boundaries, biogeographic regions (shaded, labels bolded), 250 mm and 500 mm rainfall isohyets and major towns.]

Hypothesis 3. Some plant and animal species will have become rare or disappeared from the landscape.

Hypothesis 4. Introduced species of plants and animals will have proliferated, changing ecosystem structure and function.

Methods

We set out to critically assess degradation in this region by examining test the four hypotheses outlined above using the following methods.

First, in examining the historical record, we geo-referenced observations from explorers' journals, which contain the first written descriptions of the region dating from just before the major management upheaval of pastoralism. They comprised nearly 4500 observations of vegetation, animals, people and fire from 14 journals spanning 12 expeditions between 1844 and 1919.

Next, we measured the composition and abundance of plant species at networks of long-term grazing exclosures across the four major land types: mulga forests, Mitchell grasslands, floodplains and dunefields.

Finally, we conducted targeted surveys for 91 plant species that had been identified as rare and threatened across the region between 2008 and 2015, and collated the findings about mammal declines and extinctions.

Key findings

Overall, we showed that there is little evidence for irreversible degradation of the vegetation of these parts of the country. Indeed, the results presented here provide little empirical support for the dominant prevailing narratives of degradation and ecological change.

We found that climate fluctuations and subtle soil differences often have greater effects on the composition of vegetation than does grazing. Commercial pastoralism seems in fact to be largely compatible with the conservation of plant biodiversity across most of the study area.

However, there are serious examples of degradation in inland eastern Australia, notably: .

- the loss of a suite of medium-sized mammals;
- the extinction of Great Artesian Basin springs and their dependent organisms through aquifer drawdown;
- the lack of regeneration of some palatable perennial plants; and
- invasion by prickly shrubs and buffel grass across large areas, which have altered ecosystem structure and function.

The magnitude and effects of landscape change also remain uncertain in some parts of the study area, particularly the dynamics of shrubs in the mulga lands of southern Queensland and northern New South Wales and the effect of macropod grazing in more productive areas of the landscape, and these require further investigation.

Our findings with regard to the four hypotheses were, in summary:

Hypothesis 1

The explorer record reveals little evidence of native woody vegetation thickening across inland eastern Australia, and supports the contentious hypothesis that the numbers of large kangaroos and wallabies have increased dramatically in the semi-arid zone. The numerous records of medium-sized mammals that are now locally extinct support the already well-documented decline of mammals in the critical weight-range of 35–5500 grams.

Hypothesis 2

Generally, we found few significant differences between grazing by kangaroos and grazing by commercial domestic stock on the abundance of palatable and unpalatable perennial grass species. During extended dry periods, many perennial-dominated systems become bare ground, with many shorter-lived grasses dying and persisting in the seedbank or the dominant perennials being reduced to twigs or stubble. This leads to the temporary removal of livestock, which in turn helps to ensure the persistence of the palatable perennials. The notable exception is mulga communities, whose acacias can sustain stock through drought, predisposing these communities to long-term over-grazing.

Hypothesis 3

Some species of perennial grasses, legumes and vines are probably less abundant than in the pre-pastoral landscape; however, few have declined so dramatically as to be considered rare at a landscape scale. We surveyed for species considered rare or threatened and assessed their viability in the grazed landscape, and found that many were widespread and abundant at least in good seasons.

However, plants and animals dependent on the springs of the Great Artesian Basin have declined, with numerous local extinctions.

Most striking are the declines and extinctions of formerly abundant mammals from inland eastern Australia, particularly those in the critical weight range, with 19 disappearing altogether, 12 listed as Endangered or Vulnerable and nine as Near Threatened. Birds and reptiles have fared better, with no recorded extinctions.

Myriad factors are implicated in the arid zone mammal declines and extinctions – primarily, introduced predators, habitat degradation, inappropriate fire regimes, competition from introduced herbivores, and interactions between these threats. Our results, which show that changes to vegetation and fire regimes are more modest than often assumed, support the argument that introduced predators are primarily responsible for mammal declines, at least in the study area. The timing also supports this hypothesis, with many species disappearing before pastoralism or rabbits had become established in the more arid areas, but after feral cats had colonised all of Australia by the 1890s.

Hypothesis 4

Although more than 200 exotic plants have been recorded in the study area, only a handful are substantially affecting ecosystem structure and function. Chief among these is buffel grass, which is most abundant in the eastern mulga lands, but is continuing to expand in other areas. It is destructive to biodiversity and ecosystems but productive fodder for cattle, and very difficult to control once established. Prickly acacia and mesquite are also widespread in Mitchell grasslands, transforming over 60,000 km^2 of grassland into thorny scrubland.

Feral cats and foxes represent the greatest continuing threat to surviving native fauna, and are apparently responsible for the striking disparity between dramatic fauna declines alongside the persistence of flora since European arrival.

Key findings (continued)

Rabbits continue to inhibit the recruitment of some native plant species, as do feral goats. Exotic and translocated fish, especially gambusia, carp and goldfish, pose a major threat to the biological integrity of inland waterways, and to the survival of native fish in spring-fed wetlands.

These findings lead to relatively straightforward priorities for conservation and sustainable management:

1. Control feral cats and foxes, particularly in response to booming numbers following exceptional rainfall events, to ensure the survival of vulnerable mammals.
2. Prioritise conservation of the remaining Great Artesian Basin springs and their endemic species, particularly in the face of increasing demands on groundwater for extractive industries.
3. Create large water-remote reserves that can limit the impacts of domestic, feral and native herbivores on the relatively few plant species that are sensitive to grazing.
4. Study palatable perennials with limited recruitment to shed further light on their life histories, threat status and the management required to ensure their long-term persistence.

The Cooper Creek floodplain south of Windorah, dusty and dry for much of the time, booming after a flood, May 2010. Image: Jen Silcock.

Recommendations and applications

We suggest that the very characteristics long thought to render arid lands fragile, especially the prevalence of drought and dust, dominance by annual plants, and extended periods of low groundcover, may actually confer resilience to these dryland ecosystems. A climate characterised by long dry spells punctuated by unpredictable 'boom' events, and the associated adaptations of the flora, have conferred extraordinary resilience on the ecosystems of inland eastern Australia in the face of massive management upheavals imposed by pastoral management over the past 160 years.

Multidisciplinary regional studies combining historical sources, measurement of sites with different management histories and targeted surveys for sensitive and rare elements of the flora and fauna can allow critical assessments of ecological change in regions subject to abrupt management upheavals.

We recommend that we reframe our thinking to view arid lands as resilient but unpredictable, as dependent on extended drought as on the much-celebrated booms.

However, this resilience does not extend to the ability of mammals in the critical weight range to survive predation by introduced predators, or the ability of spring-dependent species of plants and animals to survive continued aquifer drawdown. Management actions for their protection are critical.

Further Reading

Silcock, JL & Fensham, RJ (2019) Degraded or just dusty? Examining ecological change in arid lands, *Bioscience* 69:508-522.

Further Information

Jen Silcock - j.silcock@uq.edu.au

Threatened Species Recovery Hub
National Environmental Science Programme

This project is supported through funding from the Australian Government's National Environmental Science Program.