Degraded or just dusty? Examining 150 years of ecological change in inland eastern Australia

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Abstract

The ecological history of rangelands is often presented as a tale of devastation, where fragile drylands are irreversibly degraded through inappropriate land-use. There is confusion about how to recognise and measure degradation, especially in low productivity environments characterised by extreme natural variability and where abrupt management upheavals mean that there are few reference sites. These issues have important consequences for rangeland development and management programs, many of which are founded on a perception of serious and ongoing degradation from a former 'natural' state. We employ four approaches to assess degradation in inland eastern Australia, part of one of the largest desert landforms in the world and subject to recurring arguments about the cause and magnitude of landscape change since pastoral settlement 150 years ago: explorer journals dating from the 1840s, grazing exclosures, grazing gradients and identification and surveys of rare and potentially sensitive elements of the flora. We found no evidence of unidirectional change in vegetation structure, irreversible degradation of plant communities or loss of plant species, although some palatable species have declined at a landscape scale. With the exception of 12 artesian spring species, continuing declines were documented for just six plant species, while large (>1000 plants), healthy and regenerating populations of 62 of 91 species (68%) identified as rare and/or threatened were found. It is apparent that some prevailing paradigms have become entrenched despite lack of empirical evidence. However, many medium-sized mammals have declined dramatically or become extinct since European settlement, while large macropod numbers have increased dramatically in the semi-arid zone. 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 facilitate critical assessments of ecological change in regions subject to abrupt management upheavals and with contentious ecological narratives.

Introduction

The ecological history of rangelands globally is often presented as a tale of destruction and devastation. 'Degradation narratives' involving undesirable environmental change and productivity declines date from the earliest dryland civilisations. However, it was the Great Sahelian Drought of 1968-73 that swept arid-lands degradation to the forefront of the global environmental agenda (Thomas and Middleton 1994).

Some examples of degradation are well-documented and unequivocal. However, perceptions that it is a universal and perhaps inevitable consequence of land-use in arid zones are simplistic and problematic. Over the past three decades, numerous authors have questioned basic tenets underlying degradation narratives, and showed how perceptions of degradation have become entrenched despite scant empirical evidence (e.g. Addison *et al.* 2012; Davis 2004; Dodd 1994; Verón *et al.* 2006). Confusion remains about how to recognise and measure degradation. In particular, how can we distinguish characteristics inherent to aridlands from symptoms of anthropogenic

degradation, especially in the face of extreme natural variability? The implications of degradation narratives and their continued acceptance in public policy are profound, yet have rarely been explored systematically for individual areas.

The introduction of domestic and feral herbivores represents the largest Holocene environmental change in inland Australia, which had supported relatively low densities of native macropods since the extinction of the Pleistocene megafauna ≈45 000 years ago (Fensham and Fairfax 2008). Since the 1901 New South Wales Royal Commission, much work has focused on ascertaining the impacts of this major land-use upheaval. However, the magnitude and causes of ecological change since pastoral settlement remain hotly debated, both in the scientific literature and the public sphere.

Methods

We formulated five 'degradation hypotheses' based on literature review for inland eastern Australia, and employed four approaches to test them: the explorer record, a network of long-term grazing exclosures, systematic surveys for potentially rare and sensitive elements of the flora, and assessment of water-remote gradients in relation to rare plant occurrence. Details of the study area and methods can be found in Fensham *et al.* (2010), Fensham *et al.* (2011), Silcock *et al.* (2013), Silcock and Fensham (2013), Fensham *et al.* (2014), Silcock and Fensham (2014) and Silcock *et al.* (in press).

Results and discussion

Hypothesis 1. There will be clear evidence of landscape change in the historical record, particularly with regard to vegetation structure, landscape processes and relative abundance of native plant and animal species.

The explorer record reveals little evidence of unidirectional vegetation change across inland eastern Australia. Explorers recorded large areas of dense woodland and scrub in the semi-arid zone, and there are no geo-referenced observations of open country now characterised by thick vegetation. Fire was rarely mentioned, with the exception of Aboriginal burning of spinifex-dominated communities and grasslands on the eastern edge of the semi-arid zone. No change in waterhole permanence was evident for most rivers and creeks. Large macropods have increased dramatically in the semi-arid zone, while there are numerous records of medium-sized mammals that are now locally extinct or reduced to fragments within their former range.

Hypothesis 2. There will be shifts in plant species composition and abundance under different management regimes, with palatable and perennial species replaced by unpalatable and annual species in grazed areas, and an overall decline in plant species diversity which will be particularly pronounced in low productivity ecosystems.

Current grazing practices seem consistent with conservation of plant species diversity across most of inland eastern Australia, and results from exclosures and grazing gradient studies do not indicate a wholesale reduction in diversity at regional scales as would be expected with irreversible degradation. While some species, particularly palatable grasses, decreased in mulga and Mitchell grasslands, none were eliminated. It seems that non-equilibrium vegetation dynamics (Sullivan and Rohde 2002) prevail in these systems due to the sporadic nature of rainfall.

Hypothesis 3. The resulting lower groundcover, especially during drought, will lead to accelerated soil erosion, loss of nutrients and associated silting of creeks and waterbodies.

There is little evidence of silting of waterholes from the explorer record. While waterholes in localised areas, particularly the upper Lake Eyre Basin, seem to have become shallower, in other regions the explorer record refutes popular assumptions of massive soil loss and associated silting.

Soil loss is widely considered to be severe and indicative of widespread degradation in the Mulga Lands (Miles 1993), and further field research is required to explore degradation in this region.

Hypothesis 4. Some plant and animal species will have become rare or disappeared from the landscape.

A small number of plant species are disfavoured by grazing in mulga, Mitchell grasslands and the Simpson Desert, and are probably less abundant than in the pre-pastoral landscape. However, all remain widespread and common in the grazed landscape. Targeted surveys (2800 hours) for plant species considered to be rare and/or potentially threatened in western Queensland revealed many to be widespread and abundant at least in good seasons. Only six non-spring species are threatened or declining. In stark contrast, extinctions and declines of formerly abundant mammals, particularly ground-dwelling species falling within the Critical Weight Range, can only be described as catastrophic. Nineteen mammals have disappeared from inland eastern Australia, while a further 12 are listed as either Endangered or Vulnerable (Woinarski *et al.* 2014).

Hypothesis 5. Introduced species of plants and animals will have proliferated, changing ecosystem structure and function

Although more than 200 exotic flora species have been recorded in the study area, only a fraction have proliferated to substantially impact ecosystem structure and function across wide areas, notably buffel grass, prickly acacia and mesquite. Cats and foxes are the major cause of mammal declines, represent the greatest ongoing threat to surviving threatened fauna and appear to be responsible for the striking disparity between dramatic fauna declines and the persistence of the arid zone flora of inland eastern Australia. Feral herbivores occur patchily across the area, but the nature and severity of their impacts are generally not well documented.

Re-assessment of degradation narratives

Overall, there is little evidence for irreversible degradation of the soils and vegetation of inland eastern Australia, and our results generally suggest less ecological change than prevailing paradigms. Climate fluctuations and subtle soil differences often have greater effects on floristic composition than grazing, and the conservation of plant biodiversity is largely compatible with commercial pastoralism across most of the study area. The main unequivocal examples of degradation are the loss of a suite of medium-sized mammals, extinction of Great Artesian Basin springs and their dependent organisms through aquifer drawdown, and invasion of prickly shrubs and buffel grass which have altered ecosystem structure and function. There are some areas where the magnitude and effects of landscape change remain uncertain, mostly relating to the Mulga Lands.

These results point to a wider problem with identifying arid-land degradation. Assumptions of detrimental change due to abrupt management upheavals are compounded by the ‘degraded’ appearance of rangelands for much of the time. Landscape narratives can quickly become entrenched across vast regions with no unequivocal reference state. Ecological histories of rangeland areas will be as diverse as the rangelands themselves. 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.

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