

Rekindling memory of environmental repair responses to the Australian wind erosion crisis of 1930–45: ecologically aligned restoration of degraded arid-zone pastoral lands and the resultant shaping of state soil conservation policies

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January 2022

Abstract

Settlers degraded many of Australia's natural ecosystems. Environmental repair projects emerged, but collective memory of them and their significance is patchy. In one landmark but largely forgotten case, the outcomes of a series of South Australian and New South Wales repair projects played an influential role in advancing the development of arid-zone land management practices that conserved natural resources. From the 1920s scientists investigating arid-zone indigenous vegetation loss and resultant wind erosion advocated for ecologically sensitive land management practices. A set of 1930s pastoralists and conservationists implemented repair projects that restored indigenous vegetation, checked erosion and validated the ecological approach. Between 1936 and 1949 state governments impressed by these projects incorporated ecologically aligned repair practices into soil conservation policies and legislation. A start to the development in Australia of a formal, vindicated body of environmental repair thought and practice characterised by an intention to reverse degradation can be traced to approximately 1930.

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Introduction

The aridⁱ regions of south-eastern Australia were gripped by an environmental crisis between 1930 and 1945.¹ Over many decades, pastoralists had implemented ecologically inappropriate sheep and cattle stockingⁱⁱ policies, progressively degrading indigenous vegetation quality.² In conjunction with the typical low rainfall, long dry periods and rabbit plagues, these policies resulted in cyclical environmental exhaustion and collapsed ecosystems.³ By the 1930s the arid plains and low mountain ranges of central and eastern South Australia (Appendix A Map One) and western New South Wales (hereafter NSW; Appendix A Map Two) featured record levels of indigenous vegetation loss, exposed soils and accelerating rates of wind erosion.⁴

Suffocating dust storms provoked fear of widespread desertification; national morale was threatened.⁵ The danger posed by erosion to millions more hectares of still productive pastoral land raised alarm about the implications for international trade, and fuelled intense inter-war period debate about Australia's future prosperity and security.⁶

Investigating scientists identified overstocking as a significant cause of wind erosion, and suggested that it might be possible to restore indigenous vegetation within even the most severely degraded arid landscapes. This article reveals distinctive responses to those preliminary findings, by reporting a number of pioneering and influential 1930s 'environmental repair' projects undertaken by pastoralists and conservationists who restored indigenous vegetation to eroded arid ecosystems and checked wind erosion.⁷

ⁱ Average of 250 millimetres or less rainfall per year; average maximum summer temperatures of approximately 30°C or more.

ⁱⁱ Primarily sheep, but also cattle.

These projects present new perspectives on the historical development in Australia of environmental repair thought and practice characterised by an intention to reverse degradation within specified sites and ecosystems. Today, depending on the degree of recovery aspired to, this practice would be described as either rehabilitation, or ecological restoration.⁸

The earliest known repair projects undertaken by Australian settlers commenced at Port Phillip Bay, Melbourne in 1896.⁹ Indigenous vegetation was restored to foreshore ecosystems degraded by settlers. They were followed by discrete projects in Sydney (Froggatt 1931), Alstonville (Crawford 1935), and Whyalla (Morris 1935-1937) and Broken Hill (Morris 1936ⁱⁱⁱ).¹⁰ However, a start in Australia to a more systematic development, on a widespread scale, of a connected body of scientifically validated repair practices and policies is attributed to the decades following the Second World War.¹¹

The repair projects presented in this article developed in South Australia, from approximately 1930, and in NSW, from approximately 1935.^{iv} Conceptually, the projects constituted a sharp divergence from widespread settler habits of imposing stocking, vegetation and soil management preconceptions, usually of northern hemisphere origins, upon little understood and barely suitable lands.¹² They were also atypical of the many grand but poorly considered Australian forestry and irrigation schemes that often bequeathed legacies of deep environmental trouble, such as land salinity and natural resource wastage, to future generations.¹³ Instead, proponents pursued the natural regeneration of regional indigenous vegetation species, graphically demonstrating that even under conditions of typical low rainfall and extended dry periods, towering soil-drifts could be revegetated and stabilised.¹⁴

ⁱⁱⁱ Always considered a discrete repair project, a view revised in this article.

^{iv} Wind erosion afflicted north-west Victoria, but environmental repair projects were not undertaken there.

Successful revegetation outcomes spread hope among beleaguered pastoralists, conservationists and public administrators seeking effective management of wind erosion. Dramatic transformations of wasted lands lent support to Australian scientists calling for the reconciliation of pastoral industry land management practices and policies to the environmental realities of the arid regions.¹⁵ State governments were convinced and introduced ecologically aligned soil conservation policies and legislation between 1936 and 1949.

The extent, success and influence of these projects suggest that a start to the development in Australia of a formal, vindicated body of environmental repair thought and practice characterised by an intention to reverse degradation can be traced to approximately 1930, several decades earlier than previously considered.

South Australia

First Nations communities

From time immemorial a number of Aboriginal communities (language groups, nations, family groups) owned and managed homelands in regions now collectively referred to as South Australia, forming relationships of respect, reciprocity and spirituality with Country.¹⁶ Crown ownership of South Australia was proclaimed by Adelaide settlers in 1836; forced dispossession of Aboriginal people and their communities commenced.¹⁷

From the late 1830s warfare ensued between invading settlers and Aboriginal people defending homelands in the more southerly regions of South Australia (Appendix A Map One). The latter were dispossessed by approximately

1850.¹⁸ Conflict arose again between the 1850s and 1870s, when settlers with herds of cattle and sheep commenced seizing homelands in the more northerly, arid regions of central and eastern South Australia^v (Appendix A Map One).¹⁹

As the pastoral industry of the north steadily expanded, dispossessed people and communities became dependent on missions, towns and pastoral stations, where shelter, government supplies and employment might be obtained.²⁰ Poor living conditions and racial discrimination were common township experiences, and employment on stations could be harsh and exploitative.²¹ *The Aborigines Act 1911* (South Australia) imposed authoritarian state government control over individuals and families, although government regulation was less intrusive in the pastoral regions of the north.²² Reform of racially oppressive administrative and legislative provisions only commenced in the 1960s.²³

The formal historical record does not reveal participation by Aboriginal people in the 1930s South Australian environmental repair projects to be presented in this article. Overall, historical non-Aboriginal Australian society displayed little appreciation and respect for the cultural and ecological knowledge of Aboriginal nations, attitudes that only began to improve in the latter decades of the twentieth century.²⁴ Traditional Owners may have been wary of sharing knowledge because of past and prevailing injustices and exploitation, or could not share certain culturally sensitive knowledge. Even so, and despite widespread racial discrimination and social disadvantage, it is quite possible that concerned Aboriginal people and communities did make valuable but unacknowledged contributions to the repair of degraded arid-zone

^v Including the southern areas of present-day Northern Territory, once part of South Australia.

ecosystems; Aboriginal people received little credit for their significant contributions to the historical pastoral industry.²⁵

The wind erosion crisis and its management in South Australia

Pastoralism and environmental degradation

Pastoralists' land management practices consistently failed to take into account the encountered environmental realities of the exposed plains and low ranges of arid South Australia.²⁶ As early as 1865 public concern was being expressed about overstocking and the resultant loss of indigenous vegetation fodder and soil cover.²⁷

Historically, the term 'overstocking' referred to the practice of carrying more stock on a station than the land could 'support comfortably' (Figure 1).²⁸ Much of the overstocking blatantly exploited good rainfall seasons 'in the hope of obtaining the highest possible return in the briefest possible time'.²⁹

Overstocking also occurred when financially pressured pastoralists and struggling smaller stations, overstocked in the better seasons, failed to adapt stocking rates to the typical sets of drier years that regularly occurred. They were encouraged in this practice by sympathetic governments that conceded favourable rent and lease adjustments when rains failed.³⁰ Also, little formal grazing research had been conducted in Australia, and environmentally informed practices such as 'rotational grazing' were not in widespread use.³¹

Overstocking and poor management of 'aggressive grazers' like sheep initially destroyed valuable fodder and soil stabilising perennial shrubs *Atriplex spp.* saltbushes and *Maireana*^{vi} *spp.* bluebushes, followed by loss of short-lived

^{vi} Formerly *Kochia spp.*

perennial shrubs, exposing stony sub-soils (Figure 2).³² Seed production would have then fallen, triggering a decrease in the quality of remaining soil seed banks, and resulting in progressively less numbers of plants regenerating in good rain seasons, creating further loss of topsoil as protective plant cover deteriorated.



Figure 1 'There is no need to destroy [by overstocking] the natural vegetative cover, as is shown in this illustration of North-Eastern pastoral country which has carried just as many or more, livestock over the past 70 years as other similar country which has been bared'^{vii} Source: South Australian Soil Conservation Committee 1937-38

The European rabbit *Oryctolagus cuniculus*, active in South Australia from the 1870s, also contributed significantly to vegetation degradation, often destroying seedlings, regenerating shrubs and even the tree *Acacia aneura* Mulga, but the effect was variable, as shrubs such as *Cassia spp.* recovered from heavy rabbit grazing.³³ Crucially, *Atriplex vesicaria* Bladder Saltbush, a widespread, drought resistant fodder shrub that stabilised soils, was not eaten

^{vii} Figures 1-7 are presented with the complete, original captions. Some illustrations are of moderate quality. Illustrations 1-6 courtesy of South Australian Government Department of Primary Industries and Regions.

by rabbits, but poor grazing management of sheep resulted in its destruction.³⁴



*Figure 2 'A windswept plain in the north-eastern pastoral country on which only a few Spear-grass plants have appeared, despite the particularly favourable season of 1937'
Source: South Australian Soil Conservation Committee 1937-38*

Exposed by the loss of vegetation to regular regional winds, finer soil grains became airborne as dust; larger particles were gathered into drifts.³⁵

Compounding the problem, the seed of colonising species such as indigenous *Austrostipa spp.* spear grasses, ecologically critical soil stabilisers, now lacked the soil in which to germinate (Figure 2). Soil fertility was reduced.³⁶

Towering drifts of soil discouraged attempts at repair (Figure 3). Degradation of the natural ecosystems resulted in regional extinctions of indigenous animal species.³⁷

Regular rains fell throughout the 1870s, but below average rainfall and

economic recession marked the 1880s.³⁸ The 1890s were a period of severe drought and extended economic depression;³⁹ the stocking mistakes of the past were repeated, and further expanses of indigenous vegetation were destroyed.⁴⁰ In 1892 Samuel Dixon of the Royal Society of South Australia lamented the 'sandwaves' that had resulted from overstocking.⁴¹ Better rainfall seasons were experienced in the 1900s, 1910s and early 1920s, but severe dry periods characterised the later 1920s, the 1930s and 1940 to 1945.⁴² By the mid-1940s approximately 75% or more of the pre-pastoral era saltbush and bluebush plant cover of the arid pastoral lands of South Australia had been lost.⁴³

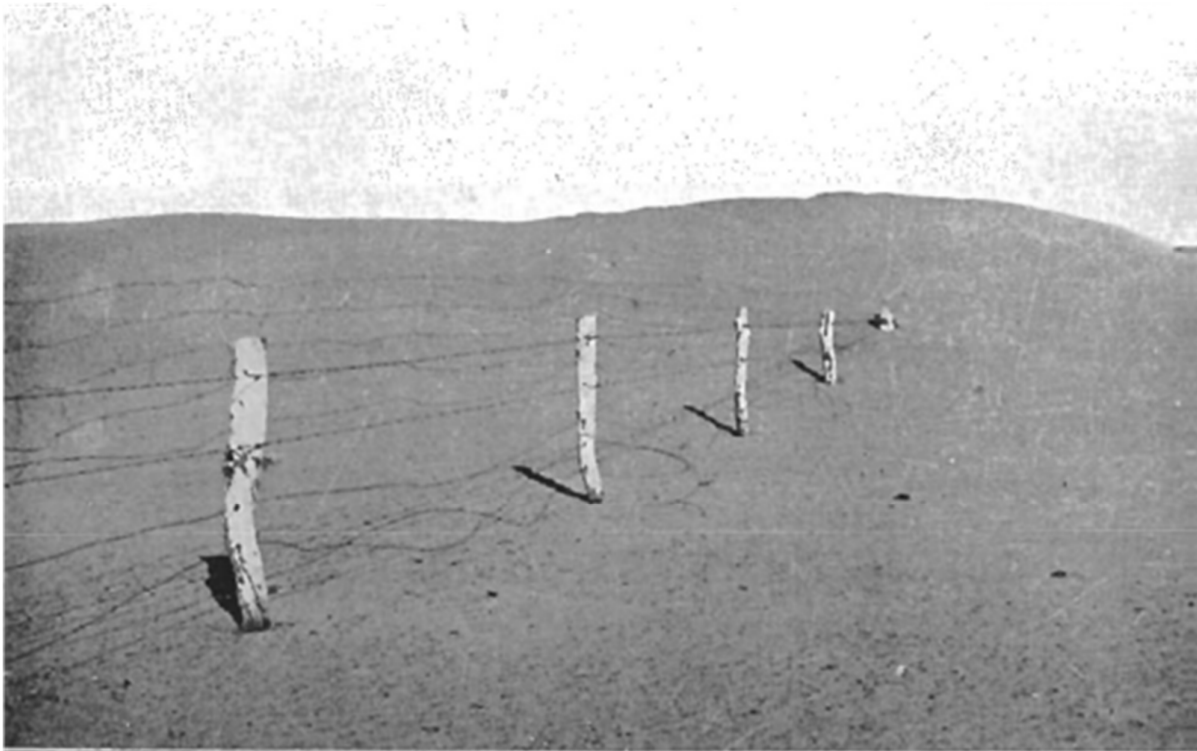


Figure 3 'Fences and public utilities such as roads, railways, reservoirs etc are liable to damage when sand drifts' Source: South Australian Soil Conservation Committee 1937-38

Research

Koonamore research reserve

From approximately 1920 widespread loss of arid-zone indigenous vegetation was troubling University of Adelaide botanist and plant ecologist Professor T G Osborn. As the number of dry periods increased, pastoralist, scientific, media and government concerns about the impacts of wind erosion climaxed in the mid-1930s.⁴⁴ Similar alarm was being expressed in the United States of America, Canada and Africa.⁴⁵

A dedicated South Australian government soil conservation entity was not established until 1939, and until then, academic researchers took the lead in studying the wind erosion issue. Initially directed by Professor Osborn, the University of Adelaide's Koonamore research facility (later T G B Osborn Reserve) was established near Yunta, eastern South Australia, in 1925, on land donated by pastoralists concerned about the impacts of grazing on indigenous vegetation regeneration.⁴⁶ Osborn's earlier botanical studies had led him to the conclusion that many of the arid-zone plant communities were dying out. His research prominently informed by ecology, an emerging science in 1920s Australia, Osborn searched for the origins of the collapse in the natural stability of the arid ecosystems.⁴⁷

It was early realized [approximately 1920] that many of the higher communities were degenerating, for no young trees or shrubs were appearing to replace those destroyed or dying of old age. It was obvious that the plant societies were being changed, and that the change was due to the influence of grazing animals. It appeared to be of some interest, and probably of economic importance, to study precisely what these changes were and how they were effected. ⁴⁸

By 1925 Osborn had arrived at a fuller appreciation of the long-term economic implications of the steady disappearance of valuable fodder species such as *Atriplex vesicaria* Bladder Saltbush and *Maireana sedifolia* Pearl Bluebush:

conservation of the natural vegetation was essential to the management of the wind erosion crisis and the long-term survival of the pastoral industry. He directly criticised overstocking, and bluntly pointed out the need to factor environmental considerations into arid-zone natural resource management and the economics of pastoralism.

The effect of their [indigenous plants] disappearance is far more far-reaching than most imagine. It means more than the loss of the particular plant; their removal has ultimately an effect on the soil itself.... There are many large-minded [pastoral station] owners who realise that the extra few thousand head that can be carried at the expense of eating out the salt bush are dearly purchased, even at the present [high] price of wool. But there are others who, for one reason or another, are allowing this to happen.... There is gradually accumulating however, a body of scientific and botanical observations on the subject. The deduction from these observations is that it is suicidal to destroy the natural flora...⁴⁹

At Koonamore Osborn studied the effects of sheep and rabbit grazing on the indigenous vegetation, and in particular, the natural regeneration of key indigenous fodder species.⁵⁰ With his research underway in 1926 but substantial results unexpected 'for some years', Osborn advised station owners to protect their 'permanent natural vegetation' from excessive grazing until research validated stocking practices had been developed.⁵¹

In August 1936 succeeding Koonamore director and botanist Professor J G Wood, University of Adelaide, delivered a Koonamore research report that confirmed the dominant role of overstocking, and not rabbits, in the destruction of arid-zone saltbush communities.⁵² Additionally, Wood presented findings on indigenous plant species' succession that shed light on the ecological complexities associated with re-establishing on eroded sites certain key perennial species.

Wood's research had revealed that natural regeneration of widespread perennial shrub species *Atriplex vesicaria* Bladder Saltbush, drought resistant and an important soil stabiliser and fodder plant, required the presence of mature Bladder Saltbush plants, as they regularly supplied fresh seed capable of germinating.⁵³ Additionally, the thorny litter of indigenous *Bassia spp.*,^{viii} prolific colonising perennial herbs and low shrubs, was also vital to saltbush regeneration, as the litter mechanically anchored in soil the wind-dispersed fresh saltbush seed, and also stabilised soils, enabling the root development of saltbush seedlings.⁵⁴ To protect the saltbush seedlings and coloniser plants, 'adequate management of grazing' was necessary.⁵⁵ Successive good rainfall seasons^{ix} were essential.⁵⁶

Therefore, fresh saltbush seed, colonising plants and their litter, careful stock management and some decent falls of rain were prerequisites for natural regeneration of Bladder Saltbush on eroded lands. Realising a combination of these preconditions on a repair site was a challenge that preoccupied and often frustrated wind erosion researchers and environmental repair practitioners in the years to come. Soil types ranging from clays to sands, and rainfall patterns often featuring many consecutive years of well below average falls, were considerations that also had to be factored into the preparation of erosion repair programs.

Wood also revealed that natural regeneration of key perennial tree species *Acacia aneura* Mulga, an effective soil binder, was reliant on stabilisation of sand and soil by colonising grasses, forbs and small shrubs and their litter, careful stock management, and the occurrence of some good rain seasons.⁵⁷ Again, these findings had clear implications for Mulga re-establishment on eroded lands.

^{viii} Historical terminology. Now includes *Sclerolaena spp.* and *Dissocarpus spp.*

^{ix} Historical regeneration events suggest rains totalling at least 250 millimetres per year for 2-3 consecutive years.

Waite Institute

Established in 1927, the Waite Agricultural Research Institute, University of Adelaide, pioneered the study of insect ecology in Australia.⁵⁸ Institute director, Dr A E V Richardson, an agricultural scientist and executive member of the national Council of Scientific and Industrial Research (hereafter CSIR), agreed that degradation of arid-zone indigenous vegetation led to soil drift, and that the role of overstocking in this process was significant.⁵⁹ He suggested in 1935 that the state government might subsidise rotational grazing and also 'undergrazing' of stock, to foster indigenous vegetation regeneration on eroded land.⁶⁰

In 1937 the Waite Institute opened a soil erosion research facility at Yudnapinna station, north-west of Port Augusta. The facility was funded by pastoralists worried about soil erosion.⁶¹ Research that explored the development of vegetation sensitive stock grazing techniques commenced in 1941, and was conducted on

*a uniform area of myall^x — bluebush country to observe the effects of different rates of stocking with sheep and of different periods of spelling, on both the vegetation and the stock.*⁶²

Preliminary results were reported in 1947: researchers found that during good rain seasons, careful distribution of stock across appropriately sized paddocks enhanced the vigour of bluebushes and also led to an increase in their rates of natural regeneration.⁶³

Australian Agricultural Council

^x *Acacia pendula*, a wattle.

The newly formed Australian Agricultural Council also addressed the wind erosion crisis. Established in 1934 and comprised of the federal and state ministers for agriculture and their advisors, the Council pursued a more cohesive national approach to Australian agricultural research.⁶⁴

The Council commissioned a CSIR investigation into South Australian wind erosion in 1935.⁶⁵ The June 1936 report of biologist Francis Ratcliffe confirmed the earlier opinions of Osborn and Richardson, concluding that

*the spread and intensification of the [erosion] trouble can only be prevented during future droughts by a radical alteration of the general stocking policy.*⁶⁶

Supportive of the report's findings, chemistry scientist and CSIR chief executive officer David Rivett publicly made clear his view that 'ignorance of the relations between natural vegetation and the soils of huge areas of the Commonwealth', along with rapid and unthinking introduction of exotic plants and animals, had significantly contributed to the degradation of the nation's indigenous vegetation 'capital' and created an environmental problem, soil erosion, 'which we do not know how to handle.'⁶⁷ The head of Australia's national scientific research body now endorsed the idea that the origins of wind erosion lay with the human disruption of the arid-zone ecosystems, and not with singular environmental impacts such as drought.⁶⁸

The concurring opinions of Osborn, Richardson, Ratcliffe and Rivett on the exploitative overstocking practices of pastoralism contributed to an emerging 1930s scientific perspective, 'a view from the land', that advocated for transition to a more environmentally attuned approach to natural resource management by the agriculture sector and government.⁶⁹ This view supported the

conservation, and not wastage, of finite and often vulnerable soil and vegetation resources, as the ongoing availability of these resources was essential to the pursuit of long-term economic and social development in Australia.

The impressive outcomes achieved by the environmental repair projects to be presented in this article were early, tangible demonstrations of the credibility of this conservation perspective on the management of natural resources. The projects revealed that ecologically aligned repair practices displayed considerable potential to effect widespread renewal of indigenous vegetation, eroded soils, abandoned lands and disrupted pastoral industry practice, and offered guidance on how natural resources might be utilised in a manner that ensured their ongoing renewal and availability.

Environmental repair projects

Stock management

Overstocking remained a common practice in the 1930s, but the long-term, detrimental outcomes attracted considerable print media attention, and a significant number of pastoralists pursued the natural regeneration of indigenous fodder vegetation such as saltbushes, bluebushes and Mulga, by way of better stocking practice. As widespread, novel attempts to reverse degradation and repair eroded lands, these efforts are noteworthy, but whether they amounted to methodical, complex projects, or were simpler, more random undertakings, is not revealed by the historical documentation.⁷⁰

The government appointed Pastoral Board was responsible for monitoring the condition of Crown lands leased by government to pastoralists. Since its establishment in 1894 the Board had largely focused on fostering pastoral industry prosperity.⁷¹ However, environmentally aligned policies that promoted

soil conservation were introduced in the 1930s, as Board inspectors had increasingly encountered overstocking and 'devastation' of indigenous fodder vegetation on their regular inspections of the arid-zone pastoral stations.⁷² By the mid-1930s inspectors were advising pastoralists that a 'portion of their holding should be spelled for a reasonable period' to facilitate regeneration of the indigenous vegetation.⁷³

The Pastoral Board reported in 1935 that 'many' pastoralists were reducing stock numbers, 'with good results', or even 'placing certain areas in reserve for a period.'⁷⁴ In 1938 the Board reported that where stock had been restricted or even completely removed on a 'considerable' number of properties in return for rent concessions, 'areas which had been windswept and badly eroded have shown appreciable progress towards recovery.'⁷⁵ The touring government Soil Conservation Committee reported in 1938 that on stations where pastoralists were prepared to 'repair the damage' by reducing stock levels or even leaving paddocks unstocked for a period, 'the progress made towards reclamation of pastoral lands has been pleasing.'⁷⁶

The Pastoral Board also directly engaged in environmental repair. For example, in 1935 a degraded pastoral lease on the Strzelecki Track was resumed and devoted to 'the regeneration of native plant life and the general recovery and stabilisation of the country' by way of careful stock management.⁷⁷

Flora reserves

A second form of indigenous vegetation restoration practice was being implemented on selected South Australian pastoral stations from approximately 1930. Stunning revegetation outcomes and exciting potential for the recovery of extensive expanses of eroded land inspired Waite Institute

director Richardson^{xi} to enthusiastically endorse 'flora reserves' in June 1936.⁷⁸ But most importantly, the reserves demonstrated beyond doubt that it was possible to reverse degradation and stabilise drifting soils (Figure 4).



Figure 4 'Native plants return to bare windswept land of the pastoral areas when protected by sheep proof fence. Five years ago this area was quite bare' Source: South Australian Soil Conservation Committee 1937-38

Flora reserves were small parcels of pastoral station land fenced and devoted to the natural regeneration of indigenous plant species within the fenced area. The largest known reserve was ten acres (four hectares) in extent. They were an intentional response to the progressive loss of regional indigenous vegetation cover and the resultant wind erosion.

The exact origins of the idea are unknown. Commenting in 1942, Reginald Ruddall MP, South Australian Commissioner for Crown Lands,^{xii} indicated that

^{xi} Also interested in using exotic plant species to manage soil-drifts.

^{xii} Member of the South Australian parliament. Liberal Country League Party. Commissioner equated to cabinet minister.

flora reserves arose from both individual initiative, and government intervention.

About 10 years ago some of the pastoralists, on their own initiative, and others at the request of Mr. N. McGilp [Pastoral Board] fenced off small reservations...with the object of ascertaining whether a period of rest from stocking would lead to a regeneration of the perennial growth of timber, shrubs and bush [saltbush and bluebush], said Mr. Rudall. These experiments had been an unqualified success. He had seen reserves at most of the stations where there was an excellent regeneration of the original flora.⁷⁹

Development of the reserves was quite possibly inspired by Osborn's work at the Koonamore research facility, but a direct connection between Osborn and the reserves is not established. Pastoralists would certainly have read of the well reported 'Koonamore Flora Reserve' research in newspapers, and the substantial recovery of indigenous fodder species achieved there between 1927 and 1929.⁸⁰

At Koonamore Osborn utilised a British stock enclosure^{xiii} research method that he had learnt of in 1922, and also natural regeneration processes, and the station flora reserves relied on the same measures to achieve revegetation.⁸¹ Of course, pastoralists may have made their own incidental observations of stock enclosure and natural regeneration, and applied them to the development of flora reserves. The South Australian government forestry industry had publicised these processes from the 1880s, and conservationists were reporting examples by the 1900s.⁸²

Osborn's interest in the application of his research findings to the broader task of reversing degradation on eroded arid-zone lands may also have stimulated

^{xiii} Protection of an area of land from grazing animals, usually by fencing.

repair work on stations.^{xiv} He delivered a publicly reported lecture on the 'rejuvenation of degraded areas' in 1929.

The [Koonamore] results so far indicated that blue-bush showed very hopeful signs of revival under sympathetic treatment. Saltbush was slower.

With paddocks averaging four by five miles in extent regeneration by seeding would be practically impossible on a grand scale, though something might be done with sowing in strips. But with acacias, including the mulga, surprising results had been obtained after selected areas had been burnt over, and it was hoped that a definite lead in this direction could be given.⁸³

Utilising many natural features and ecological processes, the flora reserve concept harmonised well with the physical realities of the arid-zone ecosystems. The reserves anticipated and accommodated the low rainfall, extended dry periods and seasonal temperature extremes typical of these ecosystems. However, a wide range of soil types and profiles prevailed across the pastoral lands, and this factor significantly influenced the occurrence and extent of plant natural regeneration.⁸⁴

Establishing a flora reserve involved the complete fencing of a degraded parcel of land, with the intention of excluding grazing animals such as sheep. The expectation was that the soil of the fenced area stored the viable seed of indigenous plant species, and possibly heavily grazed but still viable root stock; seed might also be blown into the fenced area. Moistened seed would germinate and naturally regenerated plants would thrive and distribute seed, further enhancing the reserve's soil seed bank and plant density. Drifting soils would have been stabilised.

^{xiv} Osborn's interest in the application of his research to the repair of eroded lands, and the similar interest shown by other researchers presented in this article, such as Terrence Paltridge and Noel Beadle, foreshadowed the development of restoration ecology, the science that today informs degraded area repair interventions.

The fenced flora reserves created opportunities for the natural regeneration and flourishing of the colonising annual grasses, forbs and small shrubs that deposited valuable litter and stabilised soil-drifts. As Wood had revealed in his 1936 Koonamore research report, the presence of the colonising species was essential to the regeneration of desirable perennial species such as *Atriplex vesicaria* Bladder Saltbush and *Acacia aneura* Mulga.

The earliest known flora reserve was established on Wirraminna station,^{xv} some 230 kilometres north-west of Port Augusta, in approximately 1930.⁸⁵ Owners George Jenkins MP^{xvi} and his brother and station manager Dick Jenkins developed a number of flora reserves over a period of at least eight years, the largest being ten acres (four hectares). As Minister for Agriculture in 1923, George Jenkins had known of Osborn and his botanical studies;⁸⁶ as Commissioner for Crown Lands in 1929, he was briefed on the Koonamore research work and the successful regeneration of 'bush' achieved.⁸⁷

A 1936 photograph of a Wirraminna reserve reveals abundant vegetation (Figure 5). George Jenkins reported in June 1936 that the first Wirraminna flora reserve achieved extensive revegetation outcomes within the fenced area, and stabilised soil-drifts.

'From the experience we have gained at Wirraminna station...where, owing to sand drift, a small area was fenced in and kept free from stock, I am convinced that the establishment of flora reserves is an excellent suggestion,' said Mr. Jenkins, MP...Mr Jenkins stated that... nearly all the natural flora had come back, and in spite of the drought conditions that had prevailed for some time, a number of young trees were to be seen. 'Every time I visit the

^{xv}1200 square miles in size (3000 square kilometres)

^{xvi} Member of Parliament. Jenkins served as a minister in Liberal Federation governments and then Liberal Country League governments.

*station and go through the reserve I find that some fresh shrubs have made their appearance,' he said, 'and I quite anticipate that in a few years time we will have most of the virgin bush back on this particular area.'*⁸⁸

However, the two stated estimations of the extent of indigenous vegetation recovery are vague, and contradictory. Detailed records of the regenerated vegetation, such as a species list, do not appear to be available. The region had been subjected to approximately seventy years of stocking, and the extent of Jenkins' botanical skills are unknown, so what he meant by the term 'all the natural flora' is not clear. He may have been thinking of the most commonly observed and useful indigenous trees and shrubs, or a more complex, conceptual vegetation community pieced together from observations made after rains, or derived from memory.^{xvii}

Aboriginal people were employed on Wirraminna station, and families came to be associated with the station.⁸⁹ Although unconfirmed, quite possibly members of the Kokatha, Banggarla and Wirangu nations, Traditional Owners of homelands in the extended region, worked on the station and established relationships with the Jenkins.⁹⁰ The communities of these nations were highly likely to have been able to 'maintain their customary associations with their land' and traditional cultural and social practices, despite the loss of direct control over their homelands.⁹¹ Their vegetation preferences extended to appreciation of a wide range of indigenous species that supplied sought after traditional foods and other resources.⁹² Aboriginal people have been critical of settler land management practice in Australia;⁹³ Kokatha, Banggarla and Wirangu communities may have regarded pastoral lands as being in need of repair and better ongoing management. Although unconfirmed by formal records, it is possible that regional Traditional Owners shared land management and repair insights with the Jenkins brothers that enhanced the

^{xvii} Jenkins was born in 1878.

ecological health of the station, and contributed to the development of the flora reserves.



Figure 5 'Wirraminna showing plot - formerly eaten out - fenced off from stock as compared with adjacent stocked country. Note regeneration of bush in 5 years' 1936⁹⁴ Source: H Peters Collection State Library South Australia B77568/86^{xviii}

Further Wirraminna revegetation outcomes were described by a visiting journalist in 1938.

In the largest area, which has only been fenced off for about three years and which previously was drifting very badly, we picked 47 varieties of grasses and herbage. Moreover, the area had a good growth of various shrubs, among which were a large number of sturdy young mulgas from a foot to 18 in. high. In the other areas, which had not been fenced off so long, the same conditions applied, with the exception, of course, that the young shrubs and trees were not so well advanced. Those fenced-off areas were one

^{xviii} Original caption. Library information states 'approximately 1938'. The photograph was published in the *Adelaide News* on 20/08/1936, per caption citation.

of the best demonstrations I have seen of how the back country must be treated if tree life is to be conserved and the dreaded erosion is to be overcome.⁹⁵

Whether the Wirraminna flora reserves resembled rehabilitation, or ecological restoration, two major forms of contemporary Australian environmental repair practice, is an interesting consideration.⁹⁶ See Appendix B for a discussion of this issue.

Reserves on Mr I J Warnes' Sturt Vale station^{xix} near Burra, and on Pernatty and Moolooloo stations in the north of the state, were also documented.⁹⁷ In 1942 Commissioner for Crown Lands Ruddall indicated that flora reserves were common in the more westerly areas of the South Australian pastoral zone, suggesting that the success achieved at Wirraminna station had been regionally influential.⁹⁸

As well as the valuable soil stabilisation outcomes, a further benefit had become evident by 1936.

'Not only does it [a flora reserve] result in the native flora re-establishing itself within the reserved area, but when the country has recovered it acts as a supplier of seeds, of all varieties of bushes and plants, which are deposited by birds, wind and floods over immense areas in the vicinity,' said Mr. Warnes.⁹⁹

Warnes was referring to the ecological benefits that arose from good periods of rain: dramatically increased seed production in the reserves and enhanced seed distribution. His appreciation of these benefits and the role they played in maintaining the economic viability of his station is noteworthy. Given Warnes' delight, 'all varieties' quite possibly included saltbushes and bluebushes.

^{xix}Warnes was also interested in using exotic plant species.

Speaking in June 1936, Waite director Richardson highlighted the role that flora reserves could play in the revegetation of even greater expanses of eroded land. Also, initial confirmation that a high degree of revegetation potential existed on a station reduced the financial risk and worry associated with larger projects.

*If, after a number of years, it became apparent that, by means of the reserves, the country was recovering, larger areas could be treated in the same manner...*¹⁰⁰

Crown Lands Commissioner Rudall was also supportive of the progressive enlargement of each reserve.

*The ultimate aim will be to spread the resting period over the whole area, so that by successive stages a chance of regeneration will be given to the whole of the run. This constructive work is absolutely essential. It represents a new departure in the work of the Pastoral Board, but will be the most important aspect of its future work.*¹⁰¹

George Jenkins' steady creation of additional reserves tentatively suggests that he was pursuing this outcome at Wirraminna. In 1931 he had publicly called for the careful management of stock on arid-zone stations so that in situ saltbushes and their valuable seed production capabilities were conserved.¹⁰² In 1938, and despite the 'long run of droughty and semi-droughty years', Wirraminna station displayed

*evidence of very careful management, and the result is shown very plainly by the splendid condition of the country and stock...[including] splendid salt and blue bush country.*¹⁰³

The state Erosion Committee was enthusiastic about the development of additional flora reserves on stations, and keen to extend the program across the state.¹⁰⁴ An 'astounded' Pastoral Board recorded in 1938

that where small areas had been fenced off... as permanent reserves for seeding and regeneration of plants and trees, the Board has been astounded at the remarkable recovery shown... The results attained... have had a good moral[e] effect on lessees by proving that it is mostly stock, not rabbits, that has been the cause of the depletion of pastures.¹⁰⁵

Prominent pastoralist J E Pick of Coondambo station opposed the introduction of flora reserves: fencing wire was expensive, and not always rabbit-proof. Pick preferred the incentives associated with granting leases in perpetuity, as he believed that long-term tenure would encourage careful stock management and the fostering of indigenous vegetation. In reality though, many perpetual leaseholds were in a degraded condition.¹⁰⁶

The development of flora reserves in South Australia appears to have faltered in the 1940s and 1950s, with no references being made to them in post Second World War newspapers. Fencing wire and labour were scarce and expensive throughout and for many years after the war. Also, as Wood had revealed in 1936, the absence of one or more ecological preconditions was likely to impede natural regeneration of the indigenous vegetation. Devising ways to compensate for the absence of these preconditions was still challenging researchers in 1947, as Waite Institute researcher K Woodroffe reported.

The results from stock and rabbit proof enclosures [at Yudnapinna] provide detailed proof of the slowness of the recovery of the perennial vegetation once degeneration has proceeded to a point where few, if any, live saltbush or bluebush plants are left... Very often there is a complete absence of mature plants to provide seed; suitable seed-bed conditions are lacking on a soil surface which is either hard and wind swept, or subject to continuous sand movement; appropriate seasonal conditions for effective recovery are the exception rather than the rule...¹⁰⁷

Predicting revegetation outcomes was difficult, and post war costs were high; these two considerations probably discouraged many pastoralists who were initially keen to revegetate eroded lands.

Revegetation furrowing^{xx}

A third form of environmental repair practice, the ploughing of moisture, litter and seed retaining furrows, was being implemented on pastoral stations from approximately 1930. Used in conjunction with flora reserves and the vegetation sensitive management of stock, revegetation furrowing offered real hope for the repair of large stretches of eroded arid lands (Figure 6).



Figure 6 'Recovery of vegetation on a pastoral holding in the North-East which had been bare and windswept for about 20 years, after ploughing furrows and protecting from grazing animals' Source: South Australian Soil Conservation Committee 1937-38

^{xx} Author's inclusive term for the practice. Various referred to as contour furrowing or ploughing, checkerboard ploughing, cross-ploughing, strip-ploughing, or combinations of these terms.

An early revegetation furrowing project was initiated in approximately 1930 by Walter Smith, manager of Melton station, Yunta. Osborn, Wood and CSIR plant ecologist Terrence Paltridge^{xxi} additionally utilised Melton paddocks for Koonamore research between approximately 1925 and 1930, and it would appear that Smith acted on advice offered by Paltridge.¹⁰⁸

*The essence of the system used at Melton station was to plough furrows across the direction of the prevailing winds and along contour lines in drift areas. These ploughed strips are effective in three ways: first, they tend to diminish the intensity of the drift; secondly, they collect fine sand and silt to provide a seed bed; and thirdly, they lessen the large run-off of water...in plough furrows water penetrates to a considerable depth and the vegetation remains green and healthy for a much longer time. Moreover, biennial and perennial plants can develop in these furrows.*¹⁰⁹

Paltridge was enthusiastic about the results obtained by 1935.

*For the first time in the history of saltbush grazing there is concrete evidence to show that drift can be stopped and the country re-vegetated...Native grasses and herbage soon appeared [after rain] ... rows of speargrass 18 inches high were to be seen, alternating with bare strips...where the ground had not been disturbed...The regeneration of saltbush and blue-bush and of the taller plants is a more difficult problem, as generally these only reappear as an invasion from some nearby sand.*¹¹⁰

Professor Wood was more cautious when he responded to Paltridge and the Melton furrowing outcomes: the furrows had not demonstrated a capacity to facilitate the regeneration of long-lived perennial shrub species.

Regeneration of permanent vegetation...will not take place unless a succession of good seasons occurs. I am familiar with the Melton furrows, and have observed them for about four years. Now, apparently for the first time, a good stand of speargrass has appeared,

^{xxi} Stationed at Koonamore research facility between 1928 and 1931.

*which will check the drift temporarily...As a palliative in small areas the ploughing method is practicable.'*¹¹¹

An additional environmental repair technique was also being employed at Melton station in the 1930s.

*Attempts were being made at Melton station to bring the country back by light stocking and very careful management, with apparently successful results.*¹¹²

Like Osborn, Paltridge was keen to apply research work and its outcomes to actual environmental repair projects. He explored the use of a range of repair options that enabled the reintroduction (involving human agency¹¹³) of key species such as saltbushes and Mulga to eroded lands.

*If the vast areas of the arid country that have been denuded are to be re-vegetated, it will be necessary to do more than resume a number of leases and leave the rest to Nature. Some artificial means of re-establishing the native flora must be resorted to... In order to re-establish the saltbushes and other perennial elements of the flora it may be necessary to sow seed in small cultivated areas which could be fenced off and used as nursery plots from which, on appropriate occasions, seed could be scattered... the artificial regeneration of trees (such as forcing a growth of mulgas by lighting bonfires) is not altogether impracticable.*¹¹⁴

Succeeding manager J Goddard continued to expand the Melton furrowing program, and it was quite sizeable by 1937.

*Mr Goddard has more than 2,000 acres ploughed across the line of wind, the furrows being about 4 ft. [1.3 metres] apart. These collect seed and drift and are proving an important factor in the regeneration of the country.*¹¹⁵

The summer rains of 1936-37, 1937-38 and 1939 were bountiful, and successful perennial species' regeneration on the Melton site was a reality by 1939, although saltbushes were not recorded.¹¹⁶ There was

*little sign of erosion or sand drift on any of the country that previously was so seriously affected... native trees in the form of sandalwood and acacias are making an appearance, while odd blue bushes are to be found.*¹¹⁷

The results achieved at Melton station suggest that Goodard aspired to the achievement of either substantial or full recovery of the indigenous vegetation; these aspirations are characteristic of the contemporary repair practice, ecological restoration.¹¹⁸ However, few other details about the furrowing project are available.

Revegetation furrowing was apparently being employed on quite a few, even 'many' South Australian pastoral stations by approximately 1940.¹¹⁹ The Melton outcomes may have been exceptional, as the 1938 report of the state's Soil Conservation Committee suggested that results could vary.

*Some pastoralists are attempting the reclamation of their country by ploughing furrows on bare wind-swept land, and in some cases with very pleasing results.*¹²⁰

Successful saltbush natural regeneration in furrows was recorded at Paratoo station, Yunta. Furrowing undertaken there between 1940 and 1950 produced extensive regeneration of saltbushes and bluebushes; saltbush regeneration was reported to be strong in the vicinity of mature saltbushes.¹²¹ Additionally, hand scattering of saltbush seed resulted in the reintroduction of saltbushes in extremely degraded areas. The Pastoral Board took a keen interest in the Paratoo outcomes, requesting details of the expenses involved, with the

intention of promoting the work as a model for future station furrowing projects.¹²²

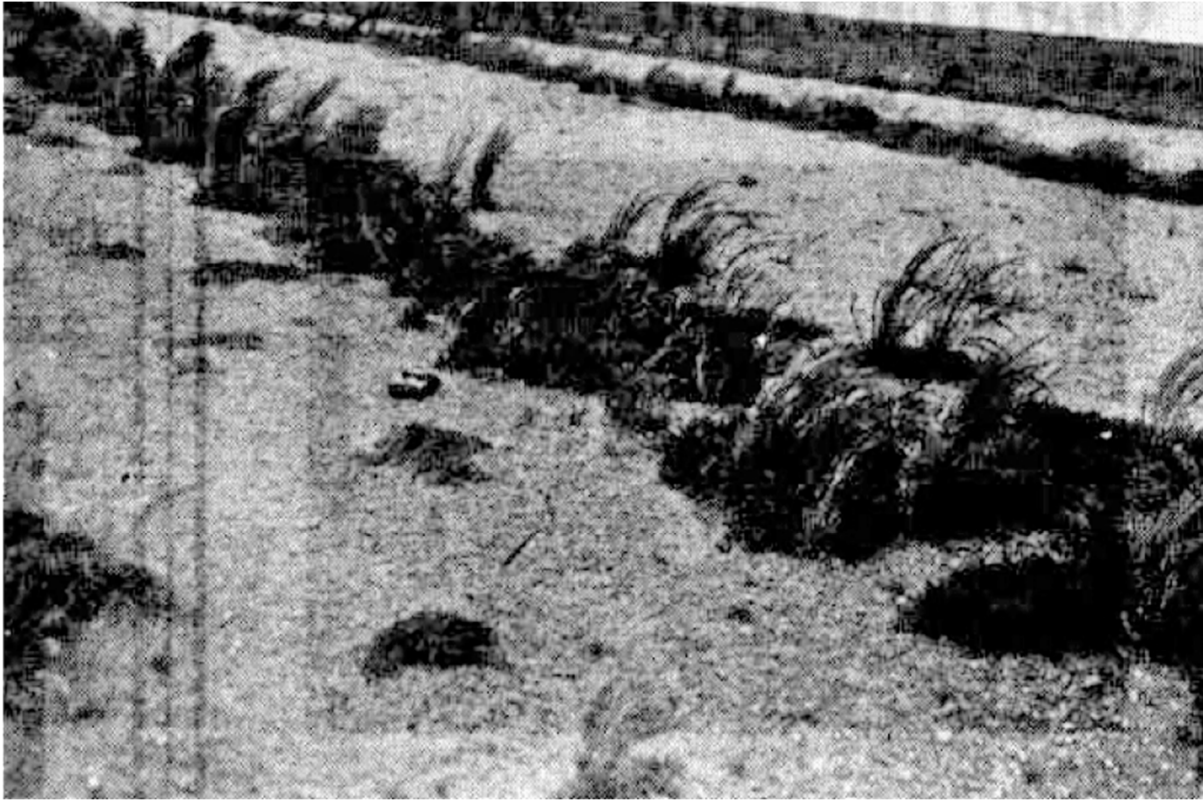


Figure 7 'Regeneration of perennial bush in degraded areas is very slow. In this case plough furrows have assisted the establishment of annual plants' Source: Woodroffe (1947)

Revegetation furrowing continued to be a widespread repair practice in the 1940s. However, if the objective was to restore perennial, indigenous fodder plants, then Waite Institute researcher Woodroffe understandably regarded furrowing, along with the development of flora reserves, as a gamble (Figure 7).^{xxii}

Many pastoralists have attempted to hasten the recovery of denuded paddocks by the ploughing of furrows, but in most cases only annual plants [grasses, forbs] have become

^{xxii} Woodroffe's research was conducted at Yudnapinna, located approximately 300 kilometres to the west of Yunta, where the substantial Melton and Paratoo station results were recorded. Woodroffe states that the soils of the north-west pastoral areas of South Australia were less fertile than those of the north-east pastoral area (Woodroffe 1947). A soil factor may explain the disappointing Yudnapinna natural regeneration results reported by Woodroffe.

*established. In a few cases saltbush seed has been sown usually with disappointing results, and it is evident that it is not yet possible, with the knowledge so far available, to assess the chances of successfully re-establishing saltbush or bluebush...*¹²³

Administrative and legislative outcomes

Alarmed at the possibility of extensive arid-zone desertification, in the mid-1930s the two major South Australian newspapers^{xxiii} prominently campaigned against overstocking.¹²⁴ They reported researchers' favourable appraisals of various environmental repair projects, and in June 1936 advocated for government subsidisation of a flora reserve program.¹²⁵ Wirraminna owner George Jenkins was of the opinion

*that the people of South Australia should be greatly indebted to 'The Advertiser' and 'The Chronicle' for the splendid publicity that had been given recently with regard to the important problem of the regeneration of the pastoral lands in arid country.*¹²⁶

Many pastoralists continued to rely on short-term government administrative and financial fixes, as well as environmentally exploitative land management practices, to maintain their businesses.¹²⁷ However, an indeterminate number of pastoralists supported the introduction of soil conservation programs that pursued environmentally aligned solutions to the wind erosion problem.

At the July 1936 meeting of the Port Augusta committee of the South Australian Stockowners Association, Jenkins spoke against the cutting of green timber. Mr Kenworthy, a pastoralist, outlined his success with flora reserves, and supported government financial assistance for pastoralists who attempted 'regeneration of country'.¹²⁸ Mr Mell, of Orreroo station, indicated that he would be happy to withdraw stock in return for an appropriate

^{xxiii} Owned by the same financial interests.

government leasehold rent subsidy. Federal member of parliament and pastoralist Philip McBride (United Australia Party) endorsed the overstocking findings of the CSIR Ratcliffe enquiry. Also in attendance, Premier Richard Butler (Liberal Country League), farmer and pastoralist, stated that the government was closely examining a range of administrative measures that supported revegetation initiatives, and additionally, he would refer the matter to the forthcoming Premiers Conference, an apex Australian political decision-making body.¹²⁹

By July 1936 an influential consensus of scientists, pastoralists and print media had concluded that overstocking resulted in devastating vegetation and soil loss, and that revegetation of soil-drifts and scalds was possible. Butler heeded the consensus and the desperate situation on the land, and announced a landmark soil conservation package in August 1936.^{xxiv} The package offered meaningful support to pastoralists set on repairing eroded lands: scientifically vindicated environmental repair techniques, along with government advice and financial assistance.¹³⁰

A reformed South Australian government soil conservation policy now embraced environmental repair measures that ‘rehabilitate natural flora in the pastoral country’ and pursued ‘light stocking’ on pastoral leaseholds.¹³¹ Pastoralists who participated in environmental repair activities qualified for financial assistance in the form of rent concessions.¹³² The Pastoral Board revealed in November 1936 that it was assisting lessees who agreed

to a reduction of the stock carried, the complete fencing of affected areas, the

^{xxiv} Professor Wood read his Koonamore research report to a meeting of the Royal Society on August 13. Although highlighting the need to manage stock carefully, the report attracted scant media attention and does not appear to have influenced the formulation of Butler’s soil conservation package, announced approximately a week later. The research report was published in December 1936.

*fencing off of small areas to act as permanent reserves for seeding and regeneration of plants and trees, the cross-ploughing or other treatment of wind-swept areas to arrest drift and promote growth, and the adoption of any other scheme which, in the Pastoral Board's opinion, should lead to the regeneration of the country.*¹³³

Although informed by extensive field observations, successful repair projects and the opinions of Osborn, Paltridge, Richardson and Ratcliffe on the detrimental effects of overstocking, Butler's soil conservation package was in some respects premature, as a comprehensive state erosion survey had never been undertaken. NSW had established an erosion study committee in 1933, and in August 1936 the Australian Agricultural Council agreed that

*each State establish a committee to study the problem of soil erosion and conservation, and to suggest a means by which correctives might be applied; the Council for Scientific and Industrial Research to co-operate with such committees.*¹³⁴

The resultant South Australian Soil Conservation Committee was chaired by John Spafford, director of the South Australian Department of Agriculture, and included Dr Richardson of the Waite Institute. During 1937 and 1938 the committee inspected a wide range of erosion and repair sites (both wind and water erosion¹³⁵) throughout South Australia, and visited a large, arid-zone natural regeneration project in Broken Hill, western NSW, a project to be presented and discussed in this article (Appendix A Maps One and Two).¹³⁶

The Soil Conservation Committee's 1938 report called for the employment of soil conservation and erosion management officers within the South Australian Department of Agriculture.¹³⁷ Among a wide range of recommendations, the report endorsed the establishment of additional flora reserves in South Australia. Stocking levels were to be stipulated in pastoral leases, and enforced. Revegetation furrowing was commended.

The Adelaide newspapers extensively reported the Soil Conservation Committee's findings and ensuing public discussion.¹³⁸ In particular, the Stockowners Association supported immediate development of more flora reserves on stations, as good rains had fallen.¹³⁹ The committee's report significantly informed the *Soil Conservation Act 1939* (South Australia) of Premier Thomas Playford's Liberal Country League state government.¹⁴⁰

The Act applied to all rural lands, including pastoral leases. Section 4 made provision for the establishment of an Advisory Committee on Soil Erosion within the Department for Agriculture.¹⁴¹ In effect though, the Committee lacked any real powers or research capacity.¹⁴²

Specific sections of the new Act reflected the interest that scientists, pastoralists and the print media had taken in the environmental repair projects conducted in South Australia since approximately 1930, and the encouraging results achieved. Section 9 conditionally authorised the Minister to create 'soil conservation reserves', which excluded stock and protected the vegetation.¹⁴³ Section 10 made provision for the construction of fences and a range of earthworks, such as 'contour banks', for soil conservation and research purposes.¹⁴⁴ Section 11 authorised the Minister to provide financial assistance to persons undertaking soil conservation works.¹⁴⁵

Crucially, Section 14 of the Act, by way of amending the *Pastoral Act 1936* (South Australia), authorised the Pastoral Board and Commissioner for Crown Lands to regulate leasehold stock numbers, prevent overstocking and save land from being 'permanently injured'.¹⁴⁶ Donovan suggests that overall, the Pastoral Board was ineffectual in its use of this power and the management of the overstocking issue throughout the 1940s.¹⁴⁷

A preceding attempt at wind erosion legislation, the *Sand Drift Act 1923* (South Australia), had not applied to Crown leaseholds, including pastoral leases, a considerable handicap.¹⁴⁸ The Act was reactive in operation, making provision for the creation of a 'breakwind reserve', to control 'any sand drift' (Section 6).¹⁴⁹ In contrast, the 1939 Act sought to 'conserve the soil' (Section 9), an intention that offered scope to both prevent and remediate erosion, and also set out a wider range of field treatment options, options that had been tried and tested throughout the decade.¹⁵⁰

New South Wales

First Nations communities

From time immemorial a number of Aboriginal communities owned and managed homelands encompassing the expansive arid plains and low mountain ranges that embraced the waters of the Baaka,^{xxv} as it was known to the people of the Barkindji nation (Appendix A Map Two). Settlers with herds of cattle and sheep commenced forcibly occupying the Baaka floodplains from the 1830s, encountering strong resistance from the Barkindji nation and other nations and communities.¹⁵¹ However, by approximately 1880 even communities living on homelands located far from the Baaka had been forced to abandon their traditional lifestyles, as pastoralists seized their lands.

Dispossessed Aboriginal people and communities were forced to rely on stations and missions for essential resources and employment.¹⁵² During the drought years of the 1890s harsh conditions on many of the stations resulted in increased deaths within Aboriginal communities.¹⁵³ People and communities were predominantly relocated to government reserves, where

^{xxv} Now also referred to as the Darling River.

strict state control over individuals and families was imposed by the *Aborigines Protection Act 1909* (NSW).¹⁵⁴ The influenza epidemic of 1919 also took a heavy toll on the Aboriginal communities of western NSW. Government regulation and confinement to reserves continued for many more decades.

The wind erosion crisis and its management in New South Wales

Pastoralism and environmental degradation

Overall, the colonial pastoral industry of western NSW engaged in land management practices that generated environmental degradation (Figure 8).¹⁵⁵ As a result, the drought years of the 1890s plunged the industry into economic crisis and depression. Overstocking and destruction of the indigenous vegetation, along with the typical low rainfall and long dry periods and droughts, were confirmed by the 1901 report of the Royal Commission into the Condition of the Crown Tenants of the Western Division to be significant causes of the depression.¹⁵⁶

The report inspired the *Western Lands Act 1901* (NSW).¹⁵⁷ A contested opinion maintains that the Act did represent an attempt by state government to adapt pastoral industry practice to the arid climate and environmental conditions of western NSW.¹⁵⁸ Section 4 of the Act introduced a Western Land Board comprised of Commissioners who administered the newly formed Western Division of NSW^{xxvi} (Map Two).¹⁵⁹ Section 18 enacted leasehold administrative reforms, and imposed innovative environmental covenants intended to control rabbits and noxious weeds, and protect green timber and indigenous fodder vegetation.¹⁶⁰

^{xxvi} An area of approximately thirty-six million hectares.



Figure 8 Broken Hill dust storm approximately 1907 Source: State Library South Australia (B54756/18)

However, specific measures to outlaw overstocking were not enacted. This omission is unsurprising. Botanist J H Maiden maintained that little dedicated wind erosion research had been undertaken in western NSW by the 1900s.¹⁶¹ Botanist Noel Beadle, in his authoritative 1948 publication, *The Vegetation and Pastures of Western New South Wales*, stated that the 'first reliable information on the ecology' of the Western Division was not produced until the early 1920s, when substantial research on arid-zone indigenous vegetation communities was published by plant ecologist Marjorie M Collins in 1923 and 1924, and botanist Albert Morris published ecological notes and indigenous plant species' lists in 1923.¹⁶²

Western Division residents looking for information on overstocking, indigenous vegetation loss and wind erosion are likely to have turned to the extensive

South Australian and NSW newspaper accounts of Professor Osborn's Koonamore research. Broken Hill^{xxvii} mining company assayer Albert Morris, a skilled botanist and conservationist aware of ecological concepts, had been interested in environmental repair for many years.¹⁶³ He had been acquainted with Osborn since at least 1921, having engaged in botanical correspondence with him that year.¹⁶⁴ Morris had certainly become aware of the Koonamore research by 1928, and quite possibly visited the not distant^{xxviii} facility.¹⁶⁵

Further strengthening the botanical and ecological connections between South Australia and NSW, Morris and plant ecologist Marjorie Collins had become acquainted in the early 1920s. A Bachelor of Science (Botany) graduate of the University of Sydney, Collins was a demonstrator in Osborn's University of Adelaide Botany Department between 1917 and approximately 1920. Having been awarded a series of Linnean Macleay Fellowships (NSW), she undertook Western Division (Barrier Range, Grey Range) plant ecology field research between approximately 1921 and 1923, and acknowledged Morris's botanical skills in her 1923 research article.¹⁶⁶ Morris was closely associated with the Barrier Field Naturalists Club, a Broken Hill natural sciences and history study club, and Collins participated in a club botanical outing on 20 August 1921.¹⁶⁷

Collins had encountered extensive indigenous vegetation loss and wind erosion while conducting her plant research, including around Broken Hill (Figure 9).¹⁶⁸

Much of the country she has investigated has been considerably overstocked and eaten out in places. The result is that the land becomes wind-swept, and big, bare areas are hardened by the wind-blown sand. Such areas are particularly inhospitable to

^{xxvii} A major NSW city in the 1930s, and an important mining industry centre. See Map Two.

^{xxviii} Approximately 250 kilometres.

*seedlings, and consequently vegetation deteriorates and desert conditions are found encroaching on arid conditions.*¹⁶⁹

These observations had convinced Collins that 'more definite' legislation was required to protect arid-zone grazing country from abuse.¹⁷⁰



Figure 9 'Typical barren hill close to Broken Hill...' Approximately 1923 Source: Miss D Nobes in M Collins¹⁷¹ Linnean Society NSW

Albert Morris, in his 1923 publication 'The Flora Between the River Darling and Broken Hill', outlined out the deeper ecological and conservation impacts of overstocking. He lamented the loss of complex indigenous vegetation communities, once habitat for unique animal species now slaughtered by the 'man on the land'.¹⁷² The depredations of cats, rabbits and foxes were noted.

Memory of the degrading impacts of overstocking faded, and the practice was again widespread by the 1920s.¹⁷³ The resultant further decline in indigenous

vegetation cover was exacerbated by poor enforcement of the Western Lands Act's regulatory provisions relating to the protection of timber and indigenous fodder vegetation.¹⁷⁴ The incidence of soil-drift noticeably worsened during the very low rainfall years of 1927 and 1929, because 'stock was kept on the country until practically every vestige of feed had been eaten out.'¹⁷⁵

As well as wind erosion in the Western Division, NSW was afflicted by extensive water erosion, particularly in the central and eastern sectors of the state, but also in Western Division regions, including the Barrier Ranges near Broken Hill.¹⁷⁶ In 1933 the NSW government of Premier Bertram Stevens (United Australia Party and Country Party coalition) exerted further state interest in environmental management by establishing an Erosion Committee to investigate the extent and seriousness of erosion in NSW.¹⁷⁷

Environmental repair projects

Revegetation furrowing trials

The five members of the Erosion Committee^{xxix} visited Broken Hill and the south of the Western Division in April 1936, to view the 'alarming' conditions there and consult with public administrators, pastoralists and residents.¹⁷⁸ Prominent contributors to the Committee's investigations were Albert Morris, Dr Ian MacGillivray and Edmund Dow, the latter also members of the Barrier Field Naturalists Club and non-pastoralist residents of Broken Hill. Along with members of the Pastoralists Association of the West Darling, they conducted the Committee members on field trips between Broken Hill and the Victorian border, and presented submissions (Appendix A Map Two).¹⁷⁹ The club and association members were not professional erosion researchers, but their well

^{xxix} The NSW Surveyor-General, a state forester, a state hydrographer, an academic and a secretary.

planned field trips covered a variety of contrasting sites that illustrated the degrading effects of overstocking and wind erosion, and the better indigenous vegetation outcomes associated with carefully managed grazing; their submissions described experimental environmental repair work and presented well researched erosion management proposals.

Morris called for the establishment of fenced, indigenous vegetation reserves on all stations. These permanent reserves would ensure regular distribution of plant seed, promoting a more widespread regeneration of vegetation.

It is suggested that each station fence a small area (preferably of several acres) to prevent access of stock, situated in a central portion of the run, where native fodder plants can grow undisturbed. This would provide a plentiful supply of seed, which would blow into surrounding areas and help after rain falls to cover the ground quickly. This project could be greatly helped by seed scattering and also by judicious planting at the right times [within the enclosed area], with local plants of all classes. Many of the fodder plants have seeds which are distributed by wind, such as most species of saltbush, grass, etc.¹⁸⁰

This proposal featured the same stock exclosure and natural regeneration principles as those used in the South Australian flora reserves. Morris had observed the beneficial effects of stock exclosure on indigenous vegetation quality in the early 1920s, and although not confirmed, it is quite possible that he studied newspaper accounts of the South Australian reserves and their successful regeneration outcomes.¹⁸¹ He intended that his particular reserve concept would enhance the recovery of the vegetation in the good rain seasons, 'and thus help the country against the bad years'.¹⁸² His emphasis on the use of 'local plants' is noteworthy.

Morris also proposed the application of two vegetation reintroduction techniques within the enclosed reserves: 'seed scattering' and 'judicious planting'. By judicious planting, Morris was referring to the planting of

seedlings propagated in a nursery, a repair practice that he was to engage in regularly.¹⁸³ Morris favoured the planting of *Atriplex nummularia* Old Man Saltbush, as experiments had led him to conclude that it was an excellent stabiliser of soil-drifts.¹⁸⁴

MacGillivray and Dow presented submissions that pointed to the cutting of green timber, collection of soil stabilising dead timber, scrub clearing and overstocking as the prime causes of vegetation and soil loss.¹⁸⁵ As Dow explained,

*the natural balance of trees must be restored or nature will take a terrible toll of the Western District... We owe it to posterity to do something to preserve the quality of the land, not to take all we can out of it, and off it, without any thought for tomorrow.*¹⁸⁶

Dow enthusiastically described to the Erosion Committee the 'afforestation' work being conducted in the United States of America to combat soil loss caused by wind and water erosion: '500 million trees had been planted on denuded lands.'¹⁸⁷ However, large-scale tree planting programs were never implemented in the arid Western Division.

The submission of the Pastoralists Association of the West Darling, presented by K G Brougham, also advocated for fenced, naturally regenerated areas of indigenous vegetation on stations.

*The association also recommended the setting apart of certain areas for regeneration of protective scrub and pasture... The association suggested a quarter of one per cent of the total area of each holding.*¹⁸⁸

As a dedicated wind erosion research facility had not been established in the Western Division, the field naturalists and two pastoralists had conducted their

own revegetation furrowing trials on two pastoral stations near Broken Hill, commencing in February 1935. Morris reported the outcomes to the Erosion Committee.¹⁸⁹ Hundreds of hectares of furrowing had been undertaken on an extensively scalded^{xxx} clay plain at Yalcowinna station by K G Brougham, and on an eroded 'stretch of country' at K Tank station by Mr Langford.¹⁹⁰

*Wind swept regions, hardened into claypans, can be ploughed at right angles to the prevailing wind of the particular district. The ridges thus set up will block drift sand containing seeds, and after rain good germination results. If stock be kept off for a period, the otherwise useless area can be brought again into production.*¹⁹¹

The furrowing was reported to be the first work of its kind to be undertaken in the Western Division.¹⁹² Following rain in January 1936, the natural regeneration of indigenous colonising plants, including *Bassia spp.* was substantial at K Tank station, 'as the broken soil with depressions held the water, which previously always ran off'.¹⁹³

*The condition of all these plants [colonisers] was healthy and they had seeded freely, the ground under the plants being thick with ripe seeds. The following season [1937] would be plentiful with these early colonisers, and would shelter the young plants of shrubs, such as old man salt bush, cassias, wattles, and the like, which could be provided in the early stages by plentiful scattering of seeds.*¹⁹⁴

Morris was obviously aware that a succession relationship existed between certain coloniser and perennial plant species. He was confident that with coloniser species in place, the reintroduction of drought resistant, long-lived perennial fodder species, such as *Atriplex nummularia* Old Man Saltbush,^{xxx} could be achieved if their seed was scattered in the furrows.

^{xxx} Scald: ground stripped of soil by wind erosion, reduced to a hardened condition and largely water impervious.

^{xxx} Low seed viability.

The Erosion Committee inspected the arid regions between Broken Hill and the Queensland border in October 1936 (Appendix A Map Two). Good rains had fallen, only minor erosion was encountered, but extensive overstocking and exploitation of Mulga and saltbushes were noted.¹⁹⁵ No environmental repair projects were recorded.

The Broken Hill regeneration area project

Albert Morris and his environmental repair colleagues in the Barrier Field Naturalists Club initiated the Broken Hill regeneration area project^{xxxii} in 1936.¹⁹⁶ Conceptually, the regeneration area project was quite similar to the flora reserves of South Australia, but significantly larger in area.¹⁹⁷

Morris had previously designed small, planted and irrigated urban tree plantations^{xxxiii} that served landscaping, amenity and conservation roles.¹⁹⁸ However, the regeneration area project was an entirely novel effort, as Morris's intention was to rely on stock enclosure, natural regeneration^{xxxiv} and the prevailing low rainfall to restore indigenous vegetation to public land, the common, that ringed the city.¹⁹⁹ The common, consisting of many hundreds of rugged hectares, had been stripped of its timber, overstocked for decades and reduced to soil-drifts.²⁰⁰ Indeterminate amounts of scald furrowing, seed scattering, irrigation and saltbush and tree planting, along with natural regeneration of the indigenous vegetation, were planned for a smaller area of degraded mining leasehold.²⁰¹ (Morris and the club also initiated two separate natural regeneration projects within the city²⁰²).

^{xxxii} The regeneration area project has been variously reported and interpreted, but not its significance within the broader environmental repair, soil conservation, administrative and legislative contexts presented in this article.

^{xxxiii} Both regional indigenous plant species and species of unspecified origins.

^{xxxiv} The regeneration area project was not an exercise in tree planting and irrigation. The project should not be confused with the small 1936-37 tree planting and irrigation plantation projects that Morris designed for the Zinc Corporation mining company to shelter and landscape a new mine site.

The healthy summer rains of 1936-37 promoted vigorous natural regeneration of indigenous grasses within the series of regeneration reserves that comprised the project, immediately stabilising drifting soils.²⁰³ Generous rains fell again in early 1939, and University of Sydney botanists Professor Eric Ashby and Ilma Pidgeon, drawn to the project by the striking natural regeneration outcomes, reported in 1940 that 'fencing the land has restored the vegetation.'²⁰⁴ Surveys by Pidgeon, Ashby and students revealed the increases in the number of indigenous perennial species to be found within the reserves.²⁰⁵ As botanist Noel Beadle subsequently confirmed, natural regeneration of perennial species was significantly better in sandier soils, such as those found at Broken Hill and Yunta, than in clay soils.²⁰⁶

Conservation ideals strongly motivated Morris, spouse Margaret Morris and their fellow field naturalists, and the regeneration area was progressively declared an indigenous plant and animal sanctuary.²⁰⁷ Crucially, three Broken Hill mining companies paid for the initial, expensive fencing. Soil drifts were enveloping residential areas of the city, and in a move that resolved both his conservation and amenity concerns, Morris persuaded the mining companies to finance the project as a community service. NSW government interest and financial commitment commenced in 1938, and following the conclusion of the Second World War, resumed in 1946, with extensive encirclement of the city by regeneration reserves completed between 1951 and 1958.²⁰⁸

Decades of botanical field work, and the 1935 field trials, informed Morris's reliance on stock enclosure and natural regeneration.²⁰⁹ Two other likely sources of inspiration were his 1920s connections with Osborn and Collins. Newspaper reports had possibly informed Morris of the environmental repair projects attempted in several Australian states by 1936: South Australia (flora reserves, furrowing), Melbourne (Donald Macdonald) and Sydney (Walter

Froggatt).²¹⁰ Regional land management lore may also have reached him: for example, clay scalds were furrowed and sown with saltbush seeds to produce a fodder crop at Boorooban, Deniliquin, in 1904.²¹¹

The available historical documentation and botanical studies suggest that the regeneration area project resembled the contemporary environmental repair practice, ecological restoration.²¹² The regional saltbush and Mulga ecosystems served as local indigenous reference ecosystems,^{xxxv} or vegetation models; substantial to full recovery of these ecosystems was aspired to and the indigenous vegetation of the conserved regeneration area thrives today; the levels of intervention were appropriate; both formal scientific and skilled local knowledge were utilised.²¹³ Residents of Broken Hill increasingly supported the project.²¹⁴ However, the historical record suggests that the Wilyakali community, Traditional Owners of regional homelands, were not consulted about the local plant communities and ecosystems, and that opportunities for them to consider engagement with the regeneration area project and repair homelands did not arise.²¹⁵

Research and legislative outcomes

The disturbing findings of the NSW Erosion Committee's investigations ensured passage of the *Soil Conservation Act 1938* (NSW) for Premier Bertram Stevens' government.²¹⁶ The Act applied to a wide range of NSW land titles, including pastoral leaseholds. It authorised the establishment of the New South Wales Soil Conservation Service, which was created the same year within the Department of Mines and Forests, and headed by 'Sam' Clayton until 1961. Clayton had studied soil erosion in NSW for many years,

^{xxxv} Much of the regional indigenous vegetation had been degraded following decades of overstocking. However, some localities, such as Mootwingee (now Mutawintji National Park), were reported by the 1936 Erosion Committee to be little affected by erosion, and the indigenous vegetation communities there may have been relatively intact.

and undertook an extensive international erosion study tour between April and November 1936.²¹⁷ Clayton also observed erosion damage in South Australia and Victoria, and at a 1937 Victorian erosion conference called for greater state and national government engagement with the issue.²¹⁸

Sections 10 and 17 of the new Act provided for the treatment of an 'area of erosion hazard', and Section 12 extended government financial assistance to soil and erosion hazard conservation projects.²¹⁹ Section 33 provided for the protection of 'timber or scrub'.²²⁰

However, unlike the South Australian *Soil Conservation Act 1939*, the *Soil Conservation Act 1938* (NSW) omitted mention of specific erosion remediation measures, such as flora reserves. One explanation for the difference between the two Acts might lie with the later start made in NSW on dedicated wind erosion research and actual environmental repair projects, relative to the progress made in South Australia. Morris and his colleagues commenced their revegetation furrowing field work in 1935, six years after Osborn's 1929 'rejuvenation' lecture, approximately five years after Jenkins' initial flora reserve was created, and at the same time that Paltridge was reporting the outcomes of five years of sustained revegetation furrowing at Melton station. Pastoralism was a more economically significant activity in South Australia compared to NSW, where the arid Western Division lands were of relatively low economic importance.²²¹ Osborn's appointment to the Chair of Botany at Adelaide University in 1912 was supported by a state government interested in the benefits that botanical research bestowed on agriculture.²²²

In his submission to the 1900-01 Royal Commission, Robert Peacock, manager of the NSW Department of Agriculture's Coolabah experimental farm, did call for careful stock management and conservation of saltbushes, but his advice, and the experimental farms, were essentially fodder and crop

orientated.²²³ Throughout the 1930s NSW erosion authority Clayton had focused on wind and water erosion surveys and community education, and substantial, ongoing erosion field research did not commence in NSW until the Soil Conservation Service was established;²²⁴ Morris and his conservation colleagues pioneered wind erosion remediation research in NSW. Also, unlike their South Australian counterparts, NSW pastoralists did not fund agricultural and erosion research institutes.

Clayton's valuable 1936 international study tour significantly informed the early drafts of a state Soil Conservation Bill, a precursor to the 1938 Act.²²⁵ Unfortunately though, Clayton was overseas when Morris and his colleagues reported to the Erosion Committee in April 1936; Clayton usually sat on the Erosion Committee.²²⁶ The first record of Clayton viewing the Broken Hill regeneration area project occurs in June 1938, only weeks before the Soil Conservation Bill was introduced to the NSW parliament.²²⁷ His visit came exactly a year after the South Australian Soil Conservation Committee had met with Morris and his repair colleagues in Broken Hill. On that occasion the committee's members, including Dr Richardson, inspected the regeneration area and were impressed by the project's scale and revegetation outcomes.²²⁸ Clayton was impressed too.

*The regeneration area scheme...on the outskirts of Broken Hill has, in the opinion of Mr. Clayton, demonstrated in a striking manner how vegetative growth could be maintained in unstocked areas, reducing to a minimum soil erosion in the area encircled.*²²⁹

Another eleven years were to pass before stock enclosure and natural regeneration principles were embodied in NSW erosion management legislation.

A start was made to dedicated Western Division wind and water erosion management research in 1939, with the appointment of botanist Noel Beadle to the Soil Conservation Service.²³⁰ Beadle was based at the Service's Condobolin research centre, located 600 kilometres to the east of Broken Hill in semi-arid^{xxxvi} country. The resource demands of the Second World War impeded the work of the new Service, and this factor may explain why a dedicated arid-zone erosion research facility was not opened until 1952.²³¹

The dramatic natural regeneration and erosion management successes of the Broken Hill regeneration area project exerted a strong influence over the state government's development of Western Division soil conservation policies and complementary legislation. Beadle must have been aware of the project and its significance by 1939, as he participated in a Linnean Society of New South Wales botanical expedition that year,^{xxxvii} and Ilma Pidgeon and female University of Sydney botanical students, also on a Linnean Society expedition, conducted a survey of the regeneration area in August.²³² He also visited the city in 1940 and 1941 (and presented lectures to members of the Barrier Field Naturalists Club). In subsequent publications Beadle noted the 'success' achieved with the 'regeneration of native plants', and outlined the three major environmental repair lessons that had been demonstrated by the regeneration area, lessons that are likely to have provided him with a head start to his wind erosion research: 'regeneration of the vegetation is possible', regeneration is 'relatively rapid' and 'exclusion of stock minimises the sand-drift problem'.²³³ Beadle was also aware of Albert Morris's ideas on fenced vegetation reserves, and saltbush planting and seed scattering.²³⁴

^{xxxvi} Average of approximately 250-450 millimetres of rainfall per year.

^{xxxvii} Wilfred A de Beuzeville, NSW government forester, botanist and ecologist, travelled with Beadle. In 1936 de Beuzeville had advised Ambrose Crawford on the selection of indigenous plant species for his pioneering Lumley Park, Alstonville, NSW, rainforest environmental repair project, commenced in 1935.

Beadle's first official Soil Conservation Service task was to undertake a botanical and erosion survey of the Western Division, an activity that consumed much of his time.²³⁵ The survey revealed that approximately seventy per cent of the Western Division's 138,000 square miles (36 million hectares) had been adversely affected by wind erosion.²³⁶ This alarming situation, exacerbated by the severe dry periods that afflicted NSW in 1940-41 and 1943-44, placed pressure on the state government to manage the issue.²³⁷ In 1944 NSW Premier William 'Bill' McKell (Australian Labor Party) undertook to restore eroded land by legislating for the regulation of overstocking and introducing other appropriate environmental repair programs.²³⁸

*Investigations by the Soil Conservation Service had disclosed that millions of acres of land in the Western Division had, as a result of wind erosion, been transformed from valuable pasturage into a veritable desert...One of the principal factors in this, a national tragedy, had been overgrazing, declared the Premier. In some cases regeneration was impossible; in others reclamation was possible by regulation of stocking and the adoption of approved measures of correction.*²³⁹

The Broken Hill regeneration area project informed McKell's ambitious Western Division 'reclamation' policy. In a May 1945 newspaper article that addressed various aspects of the reclamation policy and its viability, Sam Clayton lauded the regeneration area's stock enclosure technique, as it was 'instrumental in transforming formerly windswept country by natural regeneration'.²⁴⁰ The impressive revegetation outcomes of the South Australian flora reserves were also singled out for praise.

Additionally, Clayton perceived the need to ensure long-term conservation of the indigenous vegetation and soil resources of the Western Division, and advocated for the implementation of appropriate station stocking policies.

*If the West is to be preserved as a permanent asset and not destroyed outright by exploitation, the vegetation cover must be restored and the stocking must be kept in equilibrium with this protective vegetation cover.*²⁴¹

To maintain 'equilibrium', Beadle advised that it was necessary to determine the 'correct carrying capacity on range and treeless plain country'.²⁴² He suggested that 'grazing trials' utilising the stock enclosure and natural regeneration principles of the regeneration area project might determine stocking rates that conserved the indigenous vegetation communities of the Western Division.²⁴³ In 1946 the Soil Conservation Service commenced experiments at Condobolin that tested various stock grazing management techniques and their respective impacts on the indigenous vegetation.²⁴⁴ The nature of this work suggests that it was intended to complement McKell's Western Division reclamation policy, but this is not confirmed.

As well as conducting the Western Division botanical and erosion survey, Beadle commenced research into the remediation of eroded lands. To gain deeper understandings of regional indigenous plant ecology and insights into how eroded lands might be revegetated, he conducted experiments at the Condobolin research facility in 1940 and 1944, trialing plant natural regeneration, reintroduction and succession in furrowed scalds.²⁴⁵

*Checkerboard furrowing (single furrow ploughed at half chain intervals and crossed at right angles by a second set of furrows) and the broadcasting of suitable colonising species by sowing seed along the furrows had a real regenerative effect [on scalds].*²⁴⁶

Beadle and the Soil Conservation Service established a nursery at the Condobolin facility in 1946 to determine which plant species and their seed were best suited to sowing, and in a move reminiscent of Albert Morris's seed scattering technique, settled on *Atriplex spp.* saltbushes.²⁴⁷

Beadle appreciated the valuable role that saltbushes could play as soil stabilisers, but often saltbushes had to be reintroduced to eroded lands. He provided advice to pastoralists on the fodder value and natural distribution of various saltbush species, cultivated plants at the Condobolin nursery^{xxxviii} and supplied ecologically appropriate species to pastoralists for planting.²⁴⁸

*Regeneration of saltbush is one of the major problems in the west since the loss of perennial bush is invariably accompanied by a decrease in carrying capacity, an increased rate of wind erosion and a greater frequency of dust-storms. Many graziers are conscious of these facts while some have taken definite action to regenerate their saltbush-swards...Old man saltbush is, on account of its large bulk, ease of establishment, and drought-resistance, the best of the saltbushes and is the one to which attention should be paid. Many graziers are prepared to hand plant small areas as reserves and already several thousands of young plants have been sent out from the Soil Conservation Service's nursery at Condobolin.*²⁴⁹

As Albert Morris had explained to the NSW Erosion Committee in 1936, planting nursery raised saltbush seedlings in reserves ensured that a supply of fresh seed was regularly available for distribution by wind. Morris too, had favoured Old Man Saltbush, for its soil stabilisation qualities.

An impressed McKell had viewed the Broken Hill regeneration area during a 1946 visit to the city, and the premier subsequently initiated a Broken Hill regeneration conference to address the debilitating soil-drifts and dust storms that were afflicting the city. Beadle served as an advisor to the initial conference, held in October 1946, and confirmed the relevance of the regeneration area's revegetation outcomes to wind erosion research.²⁵⁰ Work on the project had ceased in 1939 with the death of Albert Morris and

^{xxxviii} By 1948 the nursery was selling a range of non-indigenous plant species, including *Tamarix aphylla*, Athel Pine, now a devastating weed in Australia.

commencement of the Second World War, but on McKell's instructions, plans for the fencing of further reserves and completion of the project were prepared by a Regeneration Committee consisting of residents, local and state government departments and authorities, and pastoralist and business associations. The plans were implemented between 1951 and 1958, over many hundreds of hectares.²⁵¹ Unfortunately, a proposed series of further regeneration reserves intended to revegetate thousands of hectares of the Broken Hill region and the expansive Mundi Mundi Plains did not eventuate.

Premier McKell retired from political party activity in 1947. Successor Premier McGirr (Australian Labor Party) continued to implement the Western Division reclamation policy. His government established a Western Division Conservation Advisory Committee in 1948, 'to enquire into the application of the Government's Conservation policy in the Western Division'.²⁵² The Committee was comprised of several government departments, regional pastoralists' associations and local industry representatives, and particularly investigated the possibility of creating regeneration areas around smaller Western Division towns such as Cobar, Wilcannia and Menindee, and establishing 'National Forests'.²⁵³ Regeneration reserves were established at Cobar (5000 hectares) and Bourke in the 1950s, although possibly as a result of local government initiatives. See Appendix C.

Beadle had decided by 1945 that overstocking and timber clearing were critical contributors to the development of Western Division wind erosion.²⁵⁴ He had also concluded that two major Western Division soil conservation challenges confronted the state government and the Soil Conservation Service: of highest priority was the revegetation of non-eroded soils left vulnerable to erosion because of timber clearing; effecting the remediation of eroded lands was a further challenge.²⁵⁵ In his 1948 book, *The Vegetation and*

Pastures of Western New South Wales, Beadle set out how the revegetation of non-eroded soils might be achieved over the many millions of hectares involved.

*We are confronted by a colossal task of replacing the timber in those areas where timber protection is inadequate...for large areas, even in the [semi-arid] central-west, hand-planting with its probable attendant watering questions, is out of the question...for the greater part of the western portion of the State, the only chance of regeneration is by natural establishment of the native species. The latter can be effected only by greatly reducing or completely reducing stock from the areas in question.*²⁵⁶

However, this plan faced a major obstacle. The Soil Conservation Service lacked the appropriate statutory authority to pursue mandatory natural regeneration and stock management interventions on pastoral leaseholds, lands which constituted a substantial proportion of the Western Division.

McKell's 1944 promise to regulate overstocking finally resulted in the *Western Lands (Amendment) Act 1949* (NSW) of the McGirr government.²⁵⁷ The Act enabled an even more active role for government in the development of Western Division soil conservation programs, by introducing mandatory, ecologically focused management of the regional indigenous vegetation.^{xxxix}

Section 6, sub-sections (iv) and (v) of the 1949 Act amended Section 18D of the *Western Lands Act 1901* (NSW) as operative at the time.²⁵⁸ Section 18D set out the provisions (the obligatory conditions) that applied to state government issued pastoral leases.

^{xxxix} The main purpose of the Act was to introduce reforms that addressed the small size of many pastoral leaseholds and their resultant economic and environmental limitations.

Sub-section (iv) introduced a new lease provision that allowed for the mandatory establishment of regeneration reserves and the use of stock exclosure and natural regeneration processes (not planting and irrigation measures) to restore indigenous vegetation.

(iv) A lessee shall, if the Minister so directs, prevent the use by stock of any part of the land for such periods as the Minister considers necessary to permit of natural reseeding and regeneration of vegetation; and, for this purpose, the lessee shall erect within the time appointed by the Minister such fencing as the Minister may consider necessary.

Sub-section (v) introduced a new lease provision that specifically outlawed overstocking.

(v) A lessee shall not overstock or permit or allow to be overstocked the said land, and the decision of the Commissioner as to what constitutes overstocking shall be final, and the lessee shall comply with any directions of the Commissioner to prevent or discontinue overstocking.

The wording of these new provisions allowed for their application to both eroded and non-eroded lands. The Soil Conservation Service was now equipped with the authority to implement revegetation programs on leasehold pastoral stations in order to conserve non-eroded but erosion vulnerable soils. As the only working demonstration in Australia of the efficacy of broad-scale stock exclosure and natural regeneration repair processes, there can be little doubt that the Broken Hill regeneration area project favourably influenced inclusion of the Section 6, sub-sections (iv) and (v) provisions in the proposed 1949 legislation.

The second major Western Division soil conservation challenge that Beadle had identified was the remediation of lands that were in an eroded condition.²⁵⁹ The new Section 6, sub-sections (iv) and (v) provisions of the

1949 Act enabled Soil Conservation Service targeting of this objective. However, before precise erosion remediation programs could be prepared, further research into the treatment of specific types of erosion was required. For example, the re-establishment of perennial indigenous vegetation on both soft and hard scalds was still under investigation.²⁶⁰

In 1952 a dedicated arid-zone Soil Conservation Service research station was finally opened at Fowlers Gap, approximately one hundred kilometres north of Broken Hill.²⁶¹ Beadle, who had resigned from the Service in 1946 to take up a University of Sydney position as Lecturer in Botany,^{x1} conducted an initial plant survey of the Gap station, and the Service commenced formal research there in 1954, experimenting with the remediation of specific types of erosion. In particular, the effectiveness of ponding banks, water spreading and checkerboard furrowing as scald reclamation techniques was tested; the potential of contour furrowing and trenching to stimulate 'regeneration' of *Atriplex vesicaria* Bladder Saltbush, to serve as a soil stabiliser, was examined.²⁶²

As well as the research undertaken at Fowlers Gap, in the 1950s, 1960s and 1970s the Soil Conservation Service successfully developed contour furrowing, water ponding and indigenous species' re-seeding techniques suitable for the remediation of a range of scald and sheet erosion sites. However, research into grazing management practices and policies that resulted in productive and stable Western Division soils and pasture lands comprised of indigenous plant species remained poorly developed.²⁶³

^{x1} Appointed Foundation Professor of Botany at the University of New England, Armidale, NSW, in 1955.

Conclusion

Formal research into the causes and remedies of Australian arid-zone wind erosion was at an early stage of development in the 1920s and 1930s. However, two crucial observations had emerged from plant ecology research conducted by Professor T G Osborn in the 1920s: overstocking was progressively destroying extensive areas of indigenous vegetation, leaving soils exposed and vulnerable to wind erosion; potential existed for the restoration of the indigenous vegetation, but this would involve careful management of stock.

South Australian and New South Wales pastoralists and community conservationists took note of Osborn's observations and his research. They implemented technically innovative environmental repair projects that aspired to the reversal of degradation by restoring indigenous vegetation to eroded lands. Unlike traditional pastoralist practices that unthinkingly exploited resources, the projects constructively utilised and also conserved the natural features and processes of the arid-zone ecosystems. At a time of mounting anxiety about the devastating effects of wind erosion, extensive restoration of indigenous vegetation was achieved, and drifting soils were stabilised.

These first settler attempts at the ecologically grounded repair of eroded arid lands reflected a shift in Australian natural resource management sentiment towards a more responsible consideration of the long-term environmental impacts and consequences of agricultural practice and policy. The successful repair techniques and principles were endorsed by scientists, print media and land managers, and incorporated into South Australian and NSW state soil conservation policies and legislation between 1936 and 1949.

A start to the development in Australia of a formal, scientifically vindicated body of environmental repair thought and practice characterised by an intention to reverse degradation can be traced to approximately 1930, several decades earlier than previously considered. This finding may have implications for the analysis of overall repair practice development, direction and efficacy.

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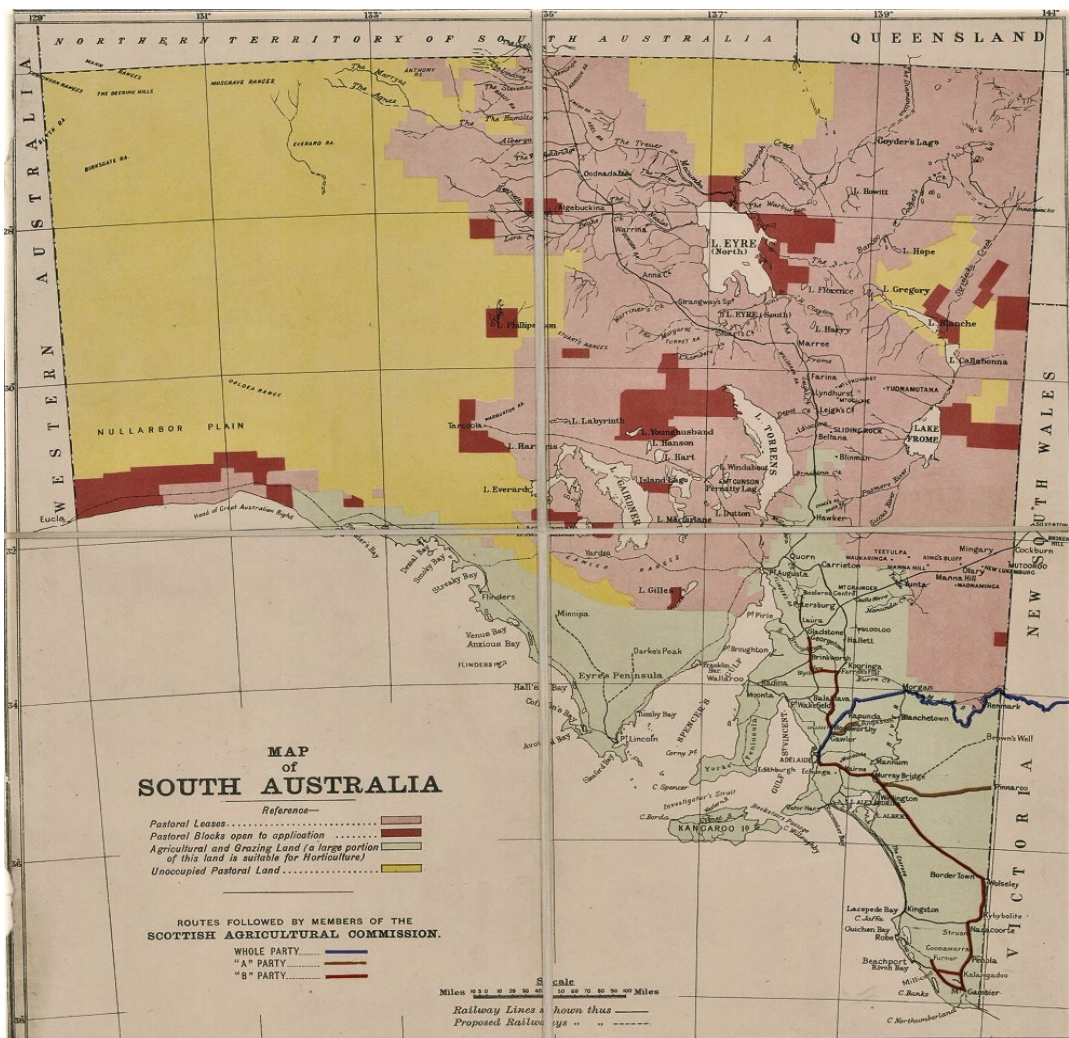
Appendix A: Maps

Map One

South Australia 1920

Notes

1. Pastoral leaseholds in South Australia approximately 1920.
2. Pastoral leaseholds at centre and right (pink shading).
3. 'Unoccupied Pastoral Land' (yellow shading) were lands not subject to a state granted lease. Aboriginal communities occupied these lands.
4. Broken Hill, New South Wales at far right, centre.



Map 1 'Map of South Australia showing pastoral leases, agricultural and grazing land 1920' Surveyor Generals Office Source: National Library Australia

Map Two

New South Wales 1934

Notes

1. Baaka (Darling River), left.
2. Broken Hill, County of Yancowinna, far left, centre.
3. Condobolin, County of Cunningham, centre.
4. Cobar, County of Robinson, left, centre; Bourke, County of Cowper, upper centre.
5. Western Division as labelled left, with boundary marked from south along Lachlan River north to Barwon River [-----].



Map 2 'Map of New South Wales Australia 1934' Department of Lands Source: National Library Australia

Appendix B: Ecological restoration

Rehabilitation, and ecological restoration, are two major forms of contemporary Australian environmental repair practice. They are characterised by an intention to reverse degradation within specified sites and ecosystems.²⁶⁴ Did the Wirraminna flora reserves exhibit features of these practices, as set out in the 'National standards for the practice of ecological restoration in Australia'?²⁶⁵

Creation of the Wirraminna reserves was intended to enable ecosystem service delivery, namely meat and wool production, by restoring eroded land to productivity; raising sheep was the priority. This focus on utilitarian outcomes initially suggests that the reserves resembled rehabilitation practice.²⁶⁶

However, the prioritisation of utilitarian objectives in a repair project does not preclude consideration of the project as ecological restoration.²⁶⁷ A key distinguishing characteristic of ecological restoration is the expression of an aspiration to achieve the full recovery of a nominated natural ecosystem, insofar as is possible, or to achieve a lesser but still substantial level of recovery in projects where insurmountable constraints exist.²⁶⁸

The historical descriptions of the Wirraminna reserves suggest that the recovery aspirations accorded with ecological restoration practice. George Jenkins was pleased with the revegetation outcomes achieved within the reserves, so it is quite possible that the statement 'I quite anticipate that in a few years time we will have most of the virgin bush back' expressed an aspiration to achieve substantial or even full recovery of the indigenous vegetation.²⁶⁹

However, Aboriginal Traditional Owners and communities had deep cultural and spiritual connections with the land involved, possessed valuable ecological knowledge and were entitled to active decision-making and management roles, but their actual levels of engagement with the project are unknown.²⁷⁰ The available historical documentation does not reveal whether the ongoing management of the reserves was consistent with the achievement of substantial or full recovery.²⁷¹ Also, the conservation status of the reserves is unknown: they were located on lands subject to a government issued lease that could be sold, and the historical information does not reveal whether preservation of the reserves was secured by a long-term conservation agreement binding the government, the Pastoral Board, the Jenkins and future lessees.²⁷² The extent of Jenkins' aspiration to restore and conserve indigenous animal species, and the manner in which indigenous herbivores were managed, are also unknown.

In summary, the Wirraminna station flora reserves did display features of the contemporary environmental repair practice, ecological restoration: substantial or even full recovery of the indigenous vegetation was aspired to; the restoration inputs were appropriate, as natural regeneration of the indigenous vegetation was allowed for; innovative, proven repair concepts, in the form of stock enclosure and the fostering of plant natural regeneration, were utilised.²⁷³ However, whether Traditional Owners and potential stakeholders engaged with the project is unknown. Also indeterminate are the levels of ecosystem functionality that were reinstated relative to a specific reference ecosystem, the ongoing management practices within and around the reserves, and the conservation status and longevity of the reserves.²⁷⁴ Although several features of ecological restoration practice are exhibited by the Wirraminna flora reserves project, further historical documentation would

be required before the Wirraminna flora reserves could be considered an ecological restoration project, or even similar to one.

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Appendix C: Bourke and Cobar regeneration areas

Directly inspired by the successes of the landscaping and regeneration area projects undertaken by Albert Morris in Broken Hill, Bourke Shire Council approved the development of an urban tree planting program and regeneration area project for the town in 1954.²⁷⁵ A certain degree of revegetation success must have been achieved within the regeneration area, as unspecified bird and terrestrial animal species were reported to be abundant in 1969.²⁷⁶ However, no other details about the historical project appear to be available, and whether the regeneration area exists today, in any form, is doubtful.

Also inspired by the Broken Hill regeneration area project, Cobar Shire Council resolved in February 1959 to develop a regeneration area within a section of the western town common.²⁷⁷ Approved by the Local Land Board and the Western Lands Commission, fencing of approximately 5000 hectares of the common was completed in October 1959, and stock were excluded.²⁷⁸ The Board anticipated that the new regeneration area would abate the severity of the Cobar dust problem, remediate existing erosion in the common, establish ongoing soil protection within a catchment area and provide a 'cooling agency' for local residents.²⁷⁹

From 1960 the Soil Conservation Service systematically monitored the natural regeneration of the indigenous vegetation within the regeneration area, setting up photographic points and conducting regular field studies. Despite a very severe drought and additional dry years, by approximately 1975 *Acacia*

aneura Mulga and other indigenous vegetation species typical of the Cobar semi-arid region had significantly recovered from previous degrading stock grazing.²⁸⁰ Anecdotal evidence suggests that some relief from dust was achieved in the urban area, as possibly the force of dust storms was dissipated by the regeneration area and its trees.²⁸¹ Cobar Shire Council continues to manage the regeneration area, referred to now as Kaloogleguy Regeneration Area.

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Acknowledgements: The author acknowledges the First Nations communities of Australia and their Elders past, present and to come. Dr S C A Sauter's Doctor of Philosophy thesis was a source of valuable background information. Many thanks to ecological restorationist Dr Tein McDonald AM and other members of the Australian Association of Bush Regenerators (AABR) for enjoyable and informative environmental repair discussions over the past five years. The National Library of Australia (Trove), State Library South Australia, Biodiversity Heritage Library and South Australian Government Department of Primary Industries and Regions provided illustrations and valuable research resources.

Disclosure: Independent, self-funded research. The analysis and opinions presented in this article are those of the author, and not of any other individual or organisation unless cited in the text. Peter Ardill BA LLB (Uni Syd) MA (UNE) is a member of the Australian Association of Bush Regenerators (AABR) and the Society for Ecological Restoration Australasia (SERA). The author accepts responsibility for all errors and omissions.

Citation: Ardill Peter J (2022) 'Rekindling memory of environmental repair responses to the Australian wind erosion crisis of 1930–45: ecologically aligned restoration of degraded arid-zone pastoral lands and the resultant shaping of state soil conservation policies' (January) *The Repair Press* Sydney

ISBN: 978-0-6451146-1-4

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Endnotes

- ¹ Cattle R C (2016) 'The case for a South-eastern Australian Dust Bowl 1895–1945' *Aeolian Research* 21:1-20 (June); Robin L (2007) *How A Continent Created A Nation* (University New South Wales Press: Sydney) 68-69; Sauter S C A (2017) 'Dust Bowls Down Under: An Environmental History of Wind Erosion in the South-East of Australia, 1929–1945/46' (Thesis for Doctor of Philosophy: University of Tubingen Germany) <https://publikationen.uni-tuebingen.de/xmlui/handle/10900/79144> Accessed 04/03/2021; Woodroffe K (1947) *Chronicle* 'Saltbush and Bluebush' 21 August p.46
- ² Barnes N E J (1997) 'Historical Changes in Land Condition in the South Australian Arid Pastoral Zone (Master Applied Science Thesis; University of Adelaide) p.14-16; Donovan P (1995) *In The Interest Of The Country* (South Australian Department Of Environment and Natural Resources: Adelaide) 81; Sauter 43, 179-180; Sendzuik P Foster R (2019 version 2 February) *A History of South Australia* (Cambridge University Press: Cambridge) 61-62
- ³ BOM (n.d.) 'Previous Droughts' *Bureau of Meteorology Australian Government* <http://www.bom.gov.au/climate/drought/knowledge-centre/previous-droughts.shtml> Accessed 21/06/21; Beadle N C W (1948) *The Vegetation and Pastures of Western New South Wales* (Department of Conservation of NSW: Sydney NSW) p.54; Barnes 14-16; Letnic M (2000) 'Dispossession, degradation and extinction: environmental history in arid Australia' *Biodiversity and Conservation* 9: 295–308; Sendzuik and Foster 61-62; Woodroffe
- ⁴ Anon *Farmer and Settler* 'Campaign Begins: First Shots Fired in War on Erosion' March 8 1934 p.3; Beadle 54; Cattle 7; Richardson A E V (1935) *Sun* 'The Problem Of Soil Drift And Its Dangers In Pastoral Areas' 14 July p.4; Robin 68-69; Sauter 43-44; Woodroffe; for the global problem see Sauter 152-155
- ⁵ Anon *Barrier Miner* 'Evils of Soil Erosion' 29 April 1938 p.4; Sauter 245-251, 421-422
- ⁶ Bonyhady T in Griffiths T (1996) *Hunters and Collectors* (Cambridge University Press: Cambridge) 156; Hutton D and Connors L (1999) *A History of the Australian Environment Movement* (Cambridge University Press: Cambridge) 57-58; Mulligan M Hill S (2001) *Ecological Pioneers* (Cambridge University Press: Cambridge) 182-183; Sauter 234-245
- ⁷ SERA (2021) Standards Reference Group 'National Standards for the Practice of Ecological Restoration in Australia' Edition 2.2. *Society for Ecological Restoration Australasia* 29, 34-39 www.seraaustralasia.com Accessed 11/09/2021 This article utilises the SERA 2021 National Standards Edition 2.2 and its terminology. Environmental repair is *any intentional activity including reduction of impacts, rehabilitation and ecological restoration that improves ecosystem functionality, ecosystem services, or biodiversity*. This article focuses on projects that displayed features of rehabilitation and ecological restoration. SERA p.31: Rehabilitation is *the process of reinstating a level of ecosystem functionality (but not substantial native biota) on degraded sites where ecological restoration is not the aspiration, as a means of enabling ongoing provision of ecosystem goods and services*. SERA p.29: Ecological restoration is *the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed*. Ongoing site conservation is an important objective in ecological restoration.
- ⁸ SERA; FAO, IUCN, CEM, SER (2021) 'Principles for ecosystem restoration to guide the United Nations Decade 2021–2030' Rome. *Food and Agriculture Organisation of the United Nations* (FAO) 7 <https://www.fao.org/documents/card/en/c/cb6591en/> Accessed 16/11/2021
- ⁹ Ardill P J (2021) 'Innovative Federation and Inter-war Period repair of degraded natural areas and their ecosystems: local government and community restoration of Coast Teatree *Leptospermum laevigatum* at Port Phillip Bay, Victoria, Australia' *The Repair Press* Sydney (February)
- ¹⁰ Ibid, (2021) 32-35; Ardill P J (2018) 'The South Australian arid zone plantation and natural regeneration work of Albert Morris' (September) Australian Association of Bush Regenerators (AABR) Sydney <https://www.aabr.org.au/morris-broken-hill/> Accessed 20/10/2021; McDonald in Jordan III W R, Lubick G M (2011) *Making Nature Whole* (Island Press: Washington) 71-75; McDonald T and Williams J (2009) 'A perspective on the evolving science and practice of ecological restoration in Australia' *Ecological Management and Restoration* 10:2 (August) 113-125 at 116 doi: 10.1111/j.1442-8903.2009.00472.x
- ¹¹ See Campbell et al, and also McDonald and Williams 116 and also Trigger D Mulcock J Gaynor A Toussaint Y (2008) 'Ecological restoration, cultural preferences and the negotiation of 'nativeness' in Australia' *Geoforum* 39 1273–1283 at 1275
- ¹² Barr N Cary J (1992) *Greening A Brown Land* (Macmillan Education: South Melbourne); Campbell A Alexandra J Curtis D (2017) 'Reflections on four decades of land restoration in Australia' *The Rangeland Journal* 39 (6) 405-416 at 406 <https://doi.org/10.1071/RJ17056> Accessed 23/04/2021; Donovan 2, 9, 73; Letnic 297-298; Lines W (1991) *Taming The Great South Land* (University of Georgia Press: Athens, Georgia); Sauter 165
- ¹³ Barr, Cary 67-73, 206-277; Lines 218-222; Robin 101; Sauter 214-222

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- ¹⁴ SERA p.31 Natural regeneration: *recovery or recruitment of species from in-situ propagules or propagules that have colonised a site without human intervention. Natural regeneration from these propagules can occur spontaneously or after facilitation other than direct human reintroduction of propagules.* Germination of naturally distributed indigenous plant seed played a significant revegetation role in the various repair projects presented in this article.
- ¹⁵ Robin 68-69; Sauter 156-157, 162-166, 174-185, 422-424
- ¹⁶ Rose D B (1996) *Nourishing Terrains: Australian Aboriginal Views of Landscape and Wilderness* (Canberra: Australian Heritage Commission)
[https://www.academia.edu/4539641/Nourishing Terrains Australian Aboriginal views of Landscape and Wilderness Australian Heritage Commission Canberra. 1996](https://www.academia.edu/4539641/Nourishing_Terrains_Australian_Aboriginal_views_of_Landscape_and_Wilderness_Australian_Heritage_Commission_Canberra_1996) Accessed 10/10/2021
- ¹⁷ Foster R and Nettlebeck A (2012) *Out of the Silence* (Wakefield Press: Kent Town South Australia) 21-22
- ¹⁸ Ibid, 98
- ¹⁹ Ibid, 100-121
- ²⁰ Sendzuik, Foster 55
- ²¹ SA Health (2021) 'South Australian Aboriginal History Timeline' *SA Health Government of South Australia* (March)
<https://www.sahealth.sa.gov.au/wps/wcm/connect/380c7d804289a9f098e2dcd8cec31b16/SA+Health+South+Australian+Aboriginal+History+Timeline.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-380c7d804289a9f098e2dcd8cec31b16-nwKxCWJ> Accessed 19/10/2021; Harding 48
- ²² Foster, Nettlebeck 144; SA Health; Harding 49,50
- ²³ SA Health; Harding 49
- ²⁴ Harding M (2016) 'Plenty of Opal Back Then: Opal Pulkah': A History of Aboriginal Engagement in the Northern South Australian Opal Industry c.1840-1980' 47 (Thesis for Doctor of Philosophy University of Adelaide) <https://digital.library.adelaide.edu.au/dspace/bitstream/2440/111998/2/02whole.pdf> Accessed 21/10/2021; Griffiths 150-152, 263; Robin 119
- ²⁵ Harding 44
- ²⁶ Donovan 7-9, 13, 73, 81
- ²⁷ Sendzuik, Foster 61-62; Barnes 14; Woodroffe 46
- ²⁸ Donovan 81
- ²⁹ Anon *Advertiser* 'Erosion and Regeneration' 31 August 1936 p.16
- ³⁰ Barnes 14; Letnic 305; Donovan 8-9, 12, 45, 49, 55-56
- ³¹ Anon (Sub-author TB Paltridge) *Chronicle* 'The Pastoralist' 15 June 1933 p.10
- ³² Barr, Cary 13; Wood J G (1936) 'Regeneration of the Vegetation on the Koonamore Vegetation Reserve, 1926 to 1936' *Transactions of the Royal Society of South Australia* (December) 60: 96-111 at 102 Biodiversity Heritage Library Washington
<https://www.biodiversitylibrary.org/item/129824#page/2/mode/1up> Accessed 05/09/2021
- ³³ Anon *Advertiser* 'Rabbits Eat Hole' 17 June 1932 p.25; Wood 107
- ³⁴ Wood 102, 104
- ³⁵ DPI (undated) 'Fact Sheet 1: Types of Erosion' *Department Primary Industry NSW Government*.
<https://www.dpi.nsw.gov.au/agriculture/soils/erosion/soil-erosion-factsheets> Accessed 28/08/2021 Wind erosion, as distinct from water erosion. *Wind moves the soil in two ways, suspension and saltation. Suspension occurs when the wind lifts finer particles into the air leading to dust storms. Saltation occurs when the wind lifts larger particles off the ground for short distances, leading to sand-drifts;* Sauter 173-174
- ³⁶ Sauter 172
- ³⁷ Letnic 302; Tunbridge D in Sendzuik and Foster 62
- ³⁸ Sendzuik, Foster 76-77
- ³⁹ Sendzuik, Foster 87
- ⁴⁰ Donovan 33, 46
- ⁴¹ Hutton, Connors 56
- ⁴² Anon *Observer* 'Far North-East' 2 March 1929 p.6; Cattle 12-13; Donovan 81; Sauter 41-43; BOM (n.d.)
- ⁴³ Woodroffe
- ⁴⁴ Sauter 43-44
- ⁴⁵ Sauter 152-156
- ⁴⁶ Robin 105
- ⁴⁷ Robin 104-105; Sauter 176-181; also Jordan, Lubick 49-53
- ⁴⁸ Anon *Observer* 'Pasture Regeneration' 5 January 1929 p.4
- ⁴⁹ Anon *Observer* 'Koonamore Vegetation Reserve' 24 January 1925 p.6
- ⁵⁰ Ibid.; Robin 105-106; Sauter 177-180
- ⁵¹ Robin 105
- ⁵² Wood 104; Sauter 179-180

- ⁵³ Wood 99, 102-104
- ⁵⁴ Ibid.
- ⁵⁵ Ibid, 109
- ⁵⁶ Ibid.
- ⁵⁷ Ibid, 108
- ⁵⁸ Mulligan, Hill 164
- ⁵⁹ Richardson
- ⁶⁰ Ibid.
- ⁶¹ Woodroffe; Anon *Chronicle* 'Soil Erosion' 6 May 1937 p.50
- ⁶² Woodroffe
- ⁶³ Ibid.
- ⁶⁴ Anon *Sydney Morning Herald* 'Agricultural Council' 5 December, 1934 p.19; Anon *Chronicle* 'Australian Agricultural Council' 23 May 1935, p.9
- ⁶⁵ Sauter 148-149
- ⁶⁶ CSIR (1936) 'Tenth Annual Report of the Council of Scientific and Industrial Research Year ended 30th June, 1936' *Council of Scientific and Industrial Research Government of the Commonwealth of Australia* <https://nla.gov.au/nla.obj-2769289935/view?sectionId=nla.obj-2792410263&partId=nla.obj-2771032895#page/n0/mode/1up> Accessed 30/04/2021; Sauter 180-182
- ⁶⁷ Robin 69; Anon *Riverine Grazier* 'Pastoral Problems' 15 January 1937 p.4
- ⁶⁸ Drought see Sauter 158-163
- ⁶⁹ Robin 68-69, 104-106
- ⁷⁰ For ecologically sensitive management of stock as environmental repair/rehabilitation see SERA 37 <https://site.emrprojectssummaries.org/2016/03/08/integrating-conservation-management-and-sheep-grazing-at-barrabool-nsw/> Accessed 21/02/2021
- ⁷¹ Donovan 78
- ⁷² Donovan 78-79
- ⁷³ Donovan 79
- ⁷⁴ Donovan 79; Donovan 83-84: as distinct from 'permanent reserves for seeding and regeneration of plants and trees.'
- ⁷⁵ Donovan 83
- ⁷⁶ SCC (1938) 'Report of the Soil Conservation Committee Together with Maps and Appendices' *Soil Conservation Committee. Adelaide Government Printer* in Davies B Gale G (2021) 'Soil Conservation and Land Management' *Department of Primary Industries and Regions South Australian Government* 13 https://www.pir.sa.gov.au/aghistorical/natural_resources/soil_conservation Accessed 25/05/2021
- ⁷⁷ Donovan 80
- ⁷⁸ Anon *Chronicle* 'Pastoral Land' 25 June 1936 p.6
- ⁷⁹ Anon *Chronicle* 'Flora regeneration in Pastoral Areas' 9 July 1942 p.6
- ⁸⁰ Anon *Observer* 'Koonamore Flora Reserve' 5 November 1927 p.5; Anon *Observer* 'Far North-East Is Drifting Mass of Devastation' 2 March 1929 p.6; Anon *Observer* 'Grazing Problems in Arid Australia' 3 August 1929 p.5
- ⁸¹ Robin 105
- ⁸² Anon *South Australian Register* 'Forestry' 13 September 1882 p.1; Ardill (2021) 24; Ardill, P J (2017) 'Albert Morris and the Broken Hill regeneration area: time, landscape and renewal' (July) *Australian Association of Bush Regenerators* Sydney 3 <https://www.aabr.org.au/morris-broken-hill/> Accessed 21/02/2021
- ⁸³ Anon *Observer* 'Grazing Problems in Arid Australia' 3 August 1929 p.5
- ⁸⁴ Beadle (1948) 82
- ⁸⁵ Anon *Transcontinental* 'Sand Makes North Line Like Sahara' 30 August 1935 p.4; Anon *News* 'Give Country A Spell' 20 August 1936 p.12
- ⁸⁶ Anon *Advertiser* 'Products Of The Land' 5 January 1923 p.11
- ⁸⁷ Anon *Observer* 'Far North-East Is Drifting' 2 March 1929 p.6
- ⁸⁸ Anon *Chronicle* 'Pastoral Land Problems' 25 June 1936 p.6
- ⁸⁹ Anon *Chronicle* 'Out Among The People' 26 January 1939 p.70 [Article contains racist and patronising references to First Nations people]; Harding 45
- ⁹⁰ AIATSIS (n.d.) 'Map of Indigenous Australia' The Australian Institute of Aboriginal and Torres Strait Islander Studies <https://aiatsis.gov.au/explore/map-indigenous-australia> Accessed 02/07/2021
- ⁹¹ Harding 46-47, 51
- ⁹² Harding 34, 37, 47
- ⁹³ Barr, Cary 101; Rose D B in Griffiths 267; Dunlop I (1995) Film: "This Is My Thinking..." Film Australia Collection in National Film and Sound Archive of Australia. Australian Institute of Aboriginal and Torres Strait Islander Studies. The Yolgnu of Yirrkala
- ⁹⁴ Anon *News* 'Passing By' 20 August 1936 p.12

- ⁹⁵ Anon *Mail* 'What I Saw In The North-West' 17 December 1938 p. 23
- ⁹⁶ SERA
- ⁹⁷ Anon *Advertiser* 'Our Country Section' 12 June 1936 p.30
- ⁹⁸ Anon *Chronicle* 'Flora Regeneration in Pastoral Areas' 9 July 1942 p.6
- ⁹⁹ Anon *Chronicle* 'Pastoral Land Problems' 25 June 1936 p.6
- ¹⁰⁰ *Ibid.*
- ¹⁰¹ Anon *Chronicle* 'Flora Regeneration in Pastoral Areas' 9 July 1942 p.6
- ¹⁰² Anon *Chronicle* 'Wheat Wool Wine' 1 October 1931 p.44
- ¹⁰³ Anon *Mail* 'What I Saw In The North-West' 17 December 1938 p. 23
- ¹⁰⁴ SCC 14; Anon *Chronicle* 'Regeneration of Pastoral Lands' 9 December, 1937 p.51
- ¹⁰⁵ Donovan 83-84
- ¹⁰⁶ Anon *Advertiser* 'Checking Soil Erosion' 11 July 1936 p.17
- ¹⁰⁷ Woodroffe
- ¹⁰⁸ Osborn T G B Wood J G Paltridge T B (1932) 'On the Growth and Re-action to Grazing of the Perennial Salt-bush, *Atriplex vesicarium*', *Proceedings of the Linnean Society of New South Wales* 57: 377-402 at 389 <https://www.biodiversitylibrary.org/bibliography/6525> Accessed 30/08/2021; Anon *Chronicle* 'Out Among the People' 10 June 1937 p.66
- ¹⁰⁹ Paltridge T B (1936) *Chronicle* 'Sheep Farmer' 9 July p.10
- ¹¹⁰ Paltridge T B (1935) *Advertiser* 'Regenerating Arid Country' 22 March p.21
- ¹¹¹ Anon *Advertiser* 'Regenerating Arid Country' 30 March 1935 p.8
- ¹¹² Anon *Chronicle* 'Difficulties of Pastoralists' 18 April 1935 p.7
- ¹¹³ SERA 32 Reintroduction is the *returning of missing species to an ecosystem through human agency, whether by direct seeding, planting, translocation or release.*
- ¹¹⁴ Paltridge (1936)
- ¹¹⁵ Anon *Chronicle* 'Checking Soil Erosion' 1 July 1937 p.10
- ¹¹⁶ BOM (2021) Monthly rainfall Yunta (Paratoo) *South Australia Bureau of Meteorology Australian Government* http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=020021 Accessed 15/05/2021
- ¹¹⁷ Anon *Chronicle* 'Conditions in North East' 9 November 1939 p.13
- ¹¹⁸ SERA 107
- ¹¹⁹ SCC 14; Woodroffe
- ¹²⁰ SCC 14
- ¹²¹ Donovan 105-106
- ¹²² *Ibid.*
- ¹²³ Woodroffe
- ¹²⁴ Anon *Advertiser* 'Overstocking In The North' 3 January 1934 p.8
- ¹²⁵ Anon *Advertiser* 'Regeneration of Pastoral Lands' 12 June 1936 p.30
- ¹²⁶ Anon *Chronicle* 'Stockowners Meet at Port Augusta' 16 July 1936 p.10
- ¹²⁷ Donovan 73-74, 81
- ¹²⁸ *Ibid.*
- ¹²⁹ *Ibid.*; Anon *Chronicle* 'Soil Erosion Problem' 16 July 1936 p.10
- ¹³⁰ Anon *Advertiser* 'Checking Soil Erosion' 24 August 1936, p.17
- ¹³¹ *Ibid.*
- ¹³² *Ibid.*
- ¹³³ Anon *Chronicle* 'Agriculture' 26 November 1936 p.5
- ¹³⁴ SCC 3
- ¹³⁵ DPI
- ¹³⁶ Anon *Chronicle* Study of Soil Erosion begins 13 May 1937 p.5
- ¹³⁷ SCC 57
- ¹³⁸ Anon *Advertiser* 'Control of Erosion' 15 October 1938 p.26
- ¹³⁹ Anon *News* 'Fencing Off Reserves in Outback' 2 March 1939 p.8
- ¹⁴⁰ AUSTRALII (n.d.) 'Soil Conservation Act 1939' (South Australia) No.25 South Australian Numbered Acts *Australasian Legal Information Institute University Technology Sydney and University NSW Faculties of Law Sydney* http://classic.austlii.edu.au/au/legis/sa/num_act/pa2274o1936161/ Accessed 31/05/2021
- ¹⁴¹ AUSTRALII (n.d.) 125
- ¹⁴² Sauter 425
- ¹⁴³ AUSTRALII (n.d.) 127
- ¹⁴⁴ *Ibid.*
- ¹⁴⁵ AUSTRALII (n.d.) 128
- ¹⁴⁶ *Ibid.*, 130-131

- ¹⁴⁷ Donovan 87, 92-93
- ¹⁴⁸ AUSTLII (n.d. 1) 'Sand Drift Act 1923' (South Australia) No.1598 South Australian Numbered Acts *Australasian Legal Information Institute* http://classic.austlii.edu.au/au/legis/sa/num_act/sda1598o1923153/ Accessed 31/05/2021
- ¹⁴⁹ AUSTLII (n.d. 1) 3
- ¹⁵⁰ AUSTLII (n.d.) 127
- ¹⁵¹ OEH (2021) 'Bioregions of NSW/A Brief overview of NSW/NSW-Regional History/New South Wales-Aboriginal occupation-Aboriginal occupation of the Western Division' p.15 *New South Wales Office of Environment and Heritage. NSW Department Planning Industry Environment. Sydney* <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Bioregions/bioregions-of-new-south-wales.pdf> Accessed 01/06/2021
- ¹⁵² Ibid.
- ¹⁵³ Ibid.
- ¹⁵⁴ Ibid.
- ¹⁵⁵ Barr, Cary 13; Collins M (1923) 'Studies in the Vegetation of Arid and Semi-Arid New South Wales' Part i: The Plant Ecology of the Barrier District' *Proceedings of the Linnean Society of New South Wales* 48 229-266 at 262 <https://www.biodiversitylibrary.org/item/109055#page/5/mode/1up> Accessed 25/08/2021; Green D R (1989) 'Rangeland Restoration Projects in Western New South Wales' *Australian Rangeland Journal* 11 (2) 110-116 at 110-111; Sauter 163-166, 187
- ¹⁵⁶ Anon *Sydney Morning Herald* 'Western Lands' 10 October 1901 p.5; Beadle 54; Sauter 29-31; Quinn M (2002) 'Committed to Conserve: The Western Lands Act, 1901, and the Management of the Public Estate of the Western Division of New South Wales' *Australian Geographical Studies* (18 December) 184 <https://doi.org/10.1111/1467-8470.00018> Accessed 17/06/2021
- ¹⁵⁷ AUSTLII (n.d. 2) 'Western Lands Act (1901) No.70 New South Wales Acts As Made. *Australasian Legal Information Institute* http://classic.austlii.edu.au/au/legis/nsw/num_act/wlao1901n70209/ Accessed 21/08/2021
- ¹⁵⁸ Quinn 184; Sauter 164
- ¹⁵⁹ AUSTLII (n.d. 2) 593
- ¹⁶⁰ Ibid, 597
- ¹⁶¹ Sauter 165
- ¹⁶² Beadle 15; Collins (1923) and Collins M (1924) 'Studies in the Vegetation of Arid and Semi-Arid New South Wales Part ii The Botanical Features of the Grey Range and its Neighbourhood' *Proceedings of the Linnean Society of New South Wales* 49 1-18 <https://www.biodiversitylibrary.org/item/109114#page/5/mode/1up> Accessed 18/08/2021; Morris A (1923) *The Flora Between the River Darling and Broken Hill* in Morris A (1975) *Plantlife of the West Darling* p.7 Second Edition (Barrier Field Naturalists Club: Broken Hill)
- ¹⁶³ Ardill (2017) 5,7
- ¹⁶⁴ Ibid, 6
- ¹⁶⁵ Ibid.
- ¹⁶⁶ Smith A (2005) 'Shiels, Marjorie (1895 - 1970)' *Encyclopedia of Australian Science* <http://www.eoas.info/biogs/P003369b.htm> Accessed 19/08/2021; Collins (1923) 251; Collins (1924)
- ¹⁶⁷ Anon *Barrier Miner* 'Field Naturalists Club' 24 August 1921 p.3
- ¹⁶⁸ Sauter 186; Collins (1923) 262
- ¹⁶⁹ Anon *Observer* 'A Sydney Scientist' 22 November 1924 p.53
- ¹⁷⁰ Ibid.
- ¹⁷¹ Collins (1923) 265
- ¹⁷² Ardill (2017) 7
- ¹⁷³ Quinn 193; Anon *Barrier Miner* 'District Erosion Problem' 30 April 1936 p.5
- ¹⁷⁴ Quinn 193; Sauter 164
- ¹⁷⁵ Anon *Barrier Miner* 'District Erosion Problem' 30 April 1936 p.5
- ¹⁷⁶ Beadle (1948) 219
- ¹⁷⁷ Sauter 329
- ¹⁷⁸ Anon *Newcastle Morning Herald and Miners' Advocate* 'Soil Erosion', 3 December 1935; Ardill (2017) 11; Sauter 330
- ¹⁷⁹ Anon *Barrier Miner* 'Overstocking and Erosion' 27 April 1936, p.1; Ardill (2017) 11; Anon *Barrier Miner* 'Erosion Can Be Checked' 23 April 1936, p.1
- ¹⁸⁰ Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁸¹ Ardill (2017) 4
- ¹⁸² Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁸³ Ibid, 15, 25

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- ¹⁸⁴ Ibid, 5; Morris A (1938) 'Broken Hill Fights Sand-Drift' *Walkabout* (November) republished in Morris A (1975) *Plantlife of the West Darling* pp.43-53 at 45-46 Second Edition (Barrier Field Naturalists Club. Broken Hill NSW)
- ¹⁸⁵ Anon *Barrier Miner* 'District Erosion Problem' 30 April 1936 p.5
- ¹⁸⁶ Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁸⁷ Ibid.
- ¹⁸⁸ Anon *Sun* 'To Prevent Soil Erosion' 28 April 1936 p.8
- ¹⁸⁹ Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁹⁰ Anon *Barrier Miner* 'Erosion Can Be Checked' 23 April 1936, p.1
- ¹⁹¹ Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁹² Anon *Barrier Miner* 'Erosion Can Be Checked' 23 April 1936, p.1
- ¹⁹³ Anon *Barrier Miner* 'Erosion Problem West of Darling' 29 April 1936 p.1
- ¹⁹⁴ Ibid.
- ¹⁹⁵ Anon *Sydney Morning Herald* 'On The Land' 14 October 1936 p.13; Anon *Sun* 'Save Mulga' 25 October 1936 p.8
- ¹⁹⁶ Ardill (2017) 19-24
- ¹⁹⁷ For Morris's two natural regeneration projects in South Australia see Ardill P J (2018)
- ¹⁹⁸ Ibid, 13-16
- ¹⁹⁹ Ibid, 25-27
- ²⁰⁰ Collins (1923) 245; Beadle (1948) 219
- ²⁰¹ Ardill (2017) 25
- ²⁰² Ibid, 17-19
- ²⁰³ Ibid, 24
- ²⁰⁴ Ibid, 24, 27, 28, 30; Pidgeon I Ashby E (1940) 'Studies in Applied Ecology I. A Statistical Analysis of Regeneration Following Protection from Grazing' *Proceedings of the Linnean Society of NSW* 65 123-143 at p.127 <http://www.biodiversitylibrary.org/bibliography/6525#/summary> Accessed 24/04/2021
- ²⁰⁵ Morris M (1939) 'Plant Regeneration in the Broken Hill District' *Australian Journal of Science* 43-48 (October) p.48; Pidgeon I Ashby E (1940) 130
- ²⁰⁶ Beadle (1948) 82
- ²⁰⁷ Ardill (2017) 25, 35
- ²⁰⁸ Ibid, 27
- ²⁰⁹ Ardill (2017)
- ²¹⁰ Ardill (2021)
- ²¹¹ Anon *Register* 'Cultivating Saltbush' 22 December 1904 p.3
- ²¹² SERA 26
- ²¹³ SERA 4-20; Tein McDonald in Jordan III, Lubick 73; Ardill (2017)
- ²¹⁴ Ardill (2017)
- ²¹⁵ First Nations communities, the regeneration area project and ecological restoration are discussed by Pearce L M (2019) 'Critical Histories for Ecological Restoration' (Thesis for Doctor of Philosophy Australian National University) 90-93 <https://openresearch-repository.anu.edu.au/handle/1885/173547> Accessed 19/10/2021
- ²¹⁶ AUSTLII (n.d. 3) 'Soil Conservation Act 1938' (NSW) No.10 NSW Acts As Made *Australasian Legal Information Institute* http://classic.austlii.edu.au/au/legis/nsw/num_act/sca1938n10242/ Accessed 09/07/2021; Sauter 327-337
- ²¹⁷ Sauter 330
- ²¹⁸ Anon *Age* 'Soil Erosion' 21 April 1937 p.16
- ²¹⁹ AUSTLII (n.d. 3) 54, 58
- ²²⁰ AUSTLII (n.d. 3) 72
- ²²¹ Sauter 139
- ²²² Sauter 177
- ²²³ Anon *Daily Telegraph* 'Western Lands Commission' 25 October 1900 p.8; Anon *Hillston Spectator and Lachlan River Advertiser* 'Lessons of the Drought' 29 January 1904 p.3; Beadle 16
- ²²⁴ Sauter 137-139, 257
- ²²⁵ Sauter 330
- ²²⁶ Sauter 329
- ²²⁷ Sauter 332
- ²²⁸ Ardill (2017) 26
- ²²⁹ Anon *Barrier Miner* 'Overstocking and Sand Drift' 22 June 1938, p.2
- ²³⁰ Sauter 139-140; Beadle (1948) 219
- ²³¹ McKell W J (1945) *West Wyalong Advocate* 'Soil Conservation Service' 22 March p.4

- ²³² Anon *Barrier Miner* 'Here To Study the Native Flora' 21 August 1939 p.3; Beadle N C W (1981) 'Forty Years Ago' *Cunninghamia* 1:1 1-6
- ²³³ Beadle (1948) 219; Beadle N C W (1946) 'Establishment of a Protected Timber Belt Westward of Broken Hill 25.ix.46'. Statement to Broken Hill Regeneration Conference of October 9, 1946. Broken Hill Regeneration Area - Old File 1945-48. Item 55/560. *New South Wales State Archive* Kingswood, NSW
- ²³⁴ Beadle (1948) 219
- ²³⁵ Anon *Farmer and Settler* 'Preventing Erosion in Western Division' 28 July 1944 p.3
- ²³⁶ Anon *Land* 'How To Protect The Soil' 27 April 1945 p.7
- ²³⁷ Anon *Farmer and Settler* 'Preventing Erosion in Western Division' 28 July 1944 p.3
- ²³⁸ Anon *Farmer and Settler* 'Attempt to Put an End to Overstocking' 20 October 1944, p.4
- ²³⁹ *Ibid.*
- ²⁴⁰ Clayton E S (1945) *Farmer and Settler* 'Overstocking Can Lead To Ruin' 18 May p.22
- ²⁴¹ *Ibid.*
- ²⁴² Beadle (1946)
- ²⁴³ *Ibid.*; Ardill (2017)
- ²⁴⁴ Sauter 188
- ²⁴⁵ Anon *Lachlander and Condobolin and Western Districts Recorder* 'Battle Against Soil Erosion' 2 February 1948 p.2; Sauter 187
- ²⁴⁶ Sauter 187-188
- ²⁴⁷ Sauter 188
- ²⁴⁸ Beadle N C W (1946a) *Riverine Grazier* 'Saltbushes' 15 October p.4
- ²⁴⁹ *Ibid.*
- ²⁵⁰ Ardill (2017) 35-36
- ²⁵¹ *Ibid.*, 32-36
- ²⁵² Anon *Barrier Daily Truth* 'Conservation Advisory Committee's Visit' 18 November 1948 p.1
- ²⁵³ *Ibid.*
- ²⁵⁴ Sauter 187
- ²⁵⁵ Beadle (1948) 79-80
- ²⁵⁶ *Ibid.*, 80-81
- ²⁵⁷ AUSTLII (n.d. 4) 'Western Lands (Amendment) Act 1949' (NSW) No.45 NSW Acts As Made *Australasian Legal Information Institute* http://classic.austlii.edu.au/au/legis/nsw/num_act/wla1949n45270/ Accessed 23/05/2021
- ²⁵⁸ AUSTLII (n.d. 4) 400
- ²⁵⁹ Beadle (1948) 79
- ²⁶⁰ *Ibid.*, 82
- ²⁶¹ Mabbutt J A (1973) 'Historical Background of Fowlers Gap Station' Chapter One: 10 in Mabbutt J A (ed.) (1973) *Lands of Fowlers Gap Station New South Wales. Fowlers Gap Arid Zone Research Station* Research Series No. 3 (University New South Wales: Sydney)
- ²⁶² *Ibid.*
- ²⁶³ Green 115
- ²⁶⁴ SERA 29, 34-39
- ²⁶⁵ SERA
- ²⁶⁶ *Ibid.*, 31
- ²⁶⁷ *Ibid.*, 29
- ²⁶⁸ *Ibid.*, 14
- ²⁶⁹ Anon *Chronicle* 'Pastoral Land Problems' 25 June 1936 p.6
- ²⁷⁰ *Ibid.*, 19
- ²⁷¹ SERA 10-13
- ²⁷² *Ibid.*, 3, 40, 42
- ²⁷³ *Ibid.*, 4-18
- ²⁷⁴ *Ibid.*, 4
- ²⁷⁵ Anon *Western Herald* 'Regeneration At Broken Hill' 25 June 1954 p.8; Anon *Western Herald* 'Tree Planting' 2 July 1954 p.12
- ²⁷⁶ Anon *Western Herald* 'Regeneration Area' 5 September 1969 p.2
- ²⁷⁷ Anon *Western Herald* 'Green Belt for Cobar' 13 February 1959 p.3
- ²⁷⁸ For an account of the regeneration area see Walker P J (1976) 'Cobar Regeneration Area – The first sixteen years' *Journal of the Soil Conservation Service of New South Wales* 32 (January-December) 119-130 *Soil Conservation Service* Sydney 119-120
- ²⁷⁹ Walker 119-120
- ²⁸⁰ Walker 130
- ²⁸¹ Walker 129

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