

## Restore, regenerate, revegetate; restoring ecological processes, ecosystems and landscapes in a changing world

R. D. B. (Wal) Whalley<sup>A,C</sup> and Rhiannon Smith<sup>B</sup>

<sup>A</sup>Botany, School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia.

<sup>B</sup>Ecosystem Management, School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia.

<sup>C</sup>Corresponding author. Email: [rwhalley@une.edu.au](mailto:rwhalley@une.edu.au)

More than 360 delegates attended *Restore, Regenerate, Revegetate: A Conference on Restoring Ecological Processes, Ecosystems and Landscapes in a Changing World* at the University of New England from 5–9 February, 2017. The Conference featured 190 presentations, including 27 presentations by invited plenary and keynote speakers, and covered the full spectrum of topics associated with environmental restoration. Delegates included scientists, practitioners, landholders, Indigenous land management groups, and government and non-government organisations. The program covered social and political facets associated with restoration; practical aspects of designing and executing restoration projects; sustainable design of restoration projects in the face of continuing landscape and climate change, and end points and goals for restoration projects. Symposia topics included:

- Seed genetics and management
- Broad-acre revegetation strategies and techniques
- Riparian restoration and revegetation
- Cost-effective revegetation and restoration
- Connectivity for biodiversity in fragmented landscapes
- Sustainable revegetation in a changing world: planning and design issues
- Revegetation for ecosystem service provision
- Restoration and indigenous NRM
- Sociology of restoration, revegetation and landscape repair
- Grazing management for biodiversity conservation
- Restoration on farms
- Soils and restoration
- Monitoring, evaluation, reporting and improvement of restoration and revegetation programs
- Policy drivers for restoration
- Invasive species and agri-ecosystem restoration
- The role of fauna in restoration

The role of the arts in communicating environmental messages was explored through thought-provoking performances, artworks and a public discussion forum, and delegates visited local restoration projects and practitioners during a <sup>3</sup>/<sub>4</sub>-day field trip.

This special issue of *The Rangeland Journal* comprises a selection of papers written by those who presented the plenary and keynote addresses at this Conference. We cannot cover all of the material presented at the Conference in this special issue, so

invite readers to seek out audio recordings of presentations online ([www.une.edu.au/about-une/academic-schools/school-of-environmental-and-rural-science/ers-news-and-events/restore-regenerate-revegetate-conference-2017](http://www.une.edu.au/about-une/academic-schools/school-of-environmental-and-rural-science/ers-news-and-events/restore-regenerate-revegetate-conference-2017)). Additional plenary and keynote addresses will also be published in 2018 in a special issue of *Ecological Management and Restoration* ([www.ecolsoc.org.au/publications/journals/emr](http://www.ecolsoc.org.au/publications/journals/emr)).

During the final plenary session of the Conference, ~120 delegates formulated and agreed unanimously to the following Declaration as part of the conference legacy. This document has since been distributed to political leaders throughout Australia in the hope that some of these recommendations will be accepted and appropriate actions taken.

### The Armidale Declaration

The delegates at the *Restore, Regenerate, Revegetate* Conference held at the University of New England, Armidale, New South Wales, from 5–9 February 2017, shared an impressive body of practical and scientific knowledge of how we are restoring Australia's natural heritage and environmental capital across the continent. However, the Conference also highlighted several key points that must be addressed if we are to truly meet the challenges and opportunities of land repair.

- We acknowledge the success of the last 30 years of land restoration and rehabilitation, but decry the continuing decline in the extent and condition of Australia's native terrestrial and aquatic ecosystems and the impact that this will have on the health, prosperity, wellbeing and cultural legacy of future Australians.
- We celebrate the significant contributions of many communities across Australia to repair their local environments. However, we have only just begun to address the vast challenge that confronts us. We have developed the skills, knowledge and passion to meet this challenge, but lack the market drivers to achieve the scale of response required.
- We urge support for Indigenous groups so they can continue to work on country to manage our natural resources through the application of cultural science.
- We urge effective action to limit human-induced climate change, which is crucial if we are to build on present and future restoration efforts.

- We recommend ensuring that the principle of ‘net gain in biodiversity’ underpins all environmental regulation.
- We recommend the development of a stable investment process that is decoupled from politics, has bipartisan support, retains and enhances social capital, and is independently administered, to support the actions and research required to reverse the ongoing decline in Australia’s natural terrestrial and aquatic ecosystems (natural capital).
- We recommend the establishment of a federal agency as the premier research and development organisation for promoting the productive and sustainable use of natural resources in rural Australia, in accord with the 2011 recommendations of the Productivity Commission.
- We recommend the support and continued development of stable, long-term government institutions for natural resource administration and management, and the facilitation of strong partnerships between government, community and industry.
- Finally, we recommend commonwealth, state and local governments define and mandate the use of native flora as an essential component in restoration and landscaping works associated with publicly funded road, rail and other infrastructure programs.

## Overview

Commencing in the latter half of the 19th Century, and accelerating through the 20th Century, major efforts were made to settle inland Australia and increase agricultural production in both the grazing and cropping industries, without due regard for the importance of native Australian ecosystems. Large swathes of native vegetation were cleared and either replaced with annual crops or with both annual and perennial introduced fodder plants for the grazing industries. A model for pasture improvement advocated by the then new Professor of Agronomy at the University of New England in his Inaugural Professorial Address in 1967 at Armidale, NSW, illustrates the attitude at that time (Fig. 1). Note that this model requires the prior destruction of the native grassland species and their replacement by higher-producing introduced pasture species from other parts of the world.

Land clearing was supported and encouraged by government policies of the times and resulted in significant biodiversity loss, soil degradation, dryland salinity and ultimately, degradation of the productive potential of the land in many regions following the loss of many ecosystem services. During the 1970s and 1980s, there was massive death of woodland eucalypts, particularly in the Tableland regions of NSW and Victoria (Nadolny 1984; Heatwole and Lowman 1986), which sparked major concern throughout Australia (Campbell *et al.* 2017). New England dieback demonstrates the complex interactions among agricultural management and decision making, climate and the wider environment, as well as the difficulties associated with reversing widespread and severe tree loss in rural landscapes (Reid and Landsberg 2000), and was therefore a key inspiration for the Conference.

Since the 1970s, there has been a period of gradual incorporation of conservation practices into Australian agriculture which have sought to repair some of the damage already done to the uniquely Australian ecosystems. More importantly, the

aim was to incorporate practices into all aspects of agriculture that would maintain the ecosystem services necessary for the long-term productivity of the landscape. The first paper in this Special Issue by Campbell *et al.* (2017), describes some of the successes and failures over the last four decades. Subsequent papers (Jones 2017a, 2017b) first look at a North American point of view, illustrating important principles that have wide application, followed by a paper (Brown and MacLeod 2017) specifically related to rangelands.

Major landscape degradation occurred in the last 40 years of the 19th Century in the rangelands of western NSW, resulting in a Royal Commission appointed to examine the condition of crown tenants in the Western Division of NSW in 1900. This Royal Commission preceded Federation and is of national significance because the witnesses appearing before it described in graphic detail the changes in the landscape of the region since the 1860s (Noble 2001). Much of this settlement began in the 1850s and 1860s and the seasons were good with abundant rainfall until dryer times commenced in the late 1880s culminating in the ‘Federation drought’. Sheep numbers in the Western Division dropped from a peak of ~15 million in 1890 to ~4 million in 1902 (Beadle 1948, Fig. 45) and there were huge losses of soil and vegetation in the region (Kerin 2001). This degradation would have resulted in major losses of ecosystem services from this region at the time. Because of their large area, rangelands are important for the ecosystem services they provide (Brown and MacLeod 2017).

The next seven papers deal with various aspects of landscape rehabilitation including a local landholder’s hands-on experience of restoration on his family farm (Williams 2017), human motivations and climate change (Prober *et al.* 2017), limitations to native seed supply (Broadhurst *et al.* 2017), the role of pollinators in restoration (Gross 2017), invasive species of plants and animals (Fleming *et al.* 2017), invasive plant management on Macquarie Island (Sindel *et al.* 2017) and designing legislation to target particular land management behaviours (Martin and Hine 2017). The final paper in this Special Issue (Hobbs 2017) looks ahead at the challenges facing landscape restoration and revegetation in a fast-changing world.

## Specific issues

### *Landscape restoration in Australia and overseas*

Reflections on the last four decades of landscape restoration in Australia reveal many instances of innovative and successful development of policy, principles and practice (Campbell *et al.* 2017). However, almost universally, these projects have lasted for some years, and then been neglected or have run their course of funding and been abandoned. Had these principles and practices been pulled together and applied throughout the nation, we would have had the world’s best natural resource management (Campbell *et al.* 2017). Unfortunately, this has not happened so advances have been sporadic and fragmentary with many instances of going forward and then going backwards.

Increasingly, worldwide attention demands that humanity must sustain ecosystem structure and function as the human population and consequently the human footprint, grows, and populations become concentrated in urban areas (Jones 2017a).

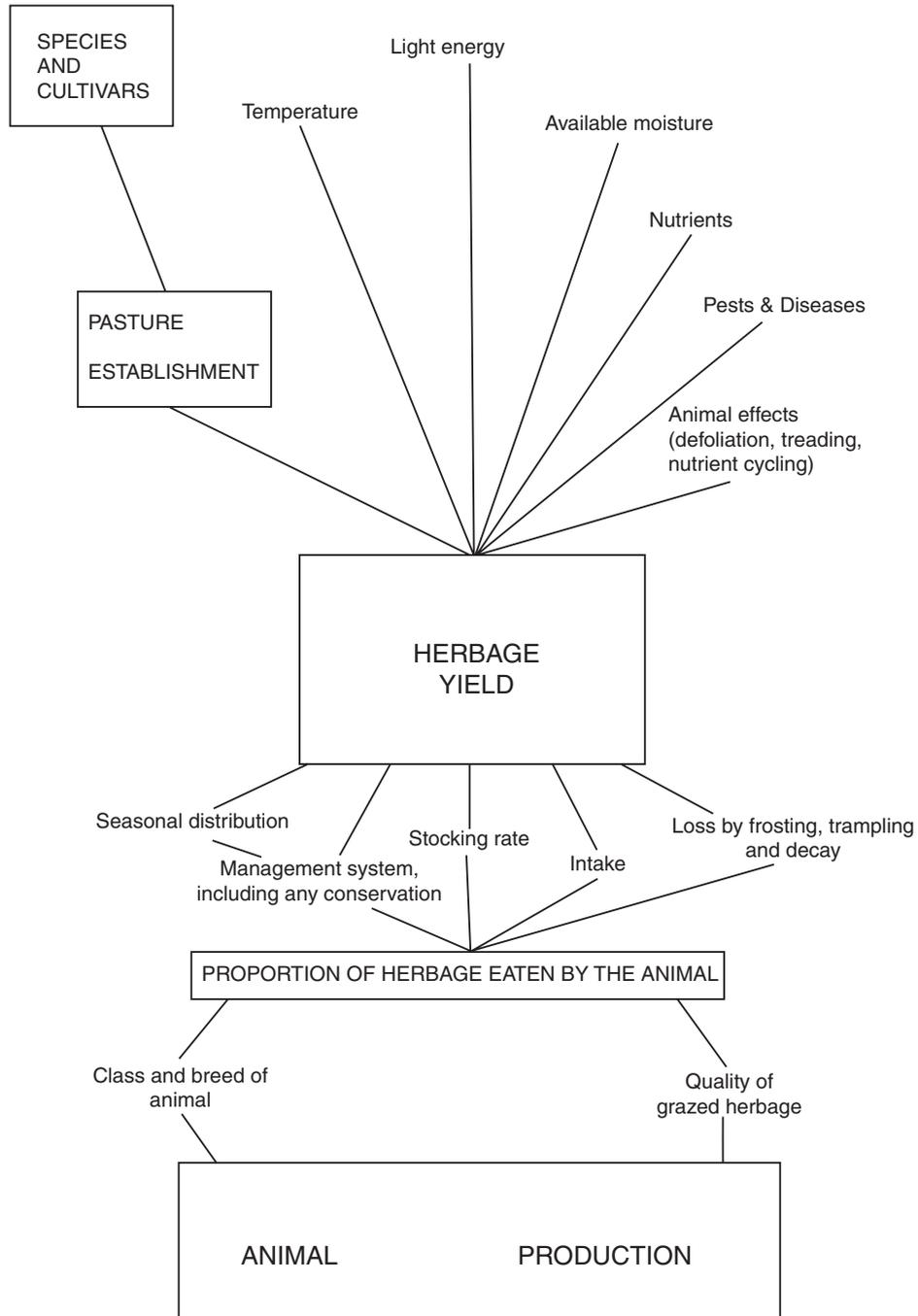


Fig. 1. Model of Pasture Improvement for temperate Australia advocated by Lazenby (1967).

On the other hand, different restoration options are being considered, particularly with increasing emphasis on functional traits instead of simple inventories of vascular plant species. In a second paper, the same author provides an interesting analysis of nine previous major ecosystem restoration attempts in the United States of America (Jones 2017b).

The fourth paper in this Special Issue stresses the importance of rangelands throughout the world in that they represent the

most extensive array of ecosystems on the planet, covering ~40% of the land surface (Brown and MacLeod 2017). However, at a national and international scale, the potential value of rangeland restoration projects has not attracted sufficient interest from the public and funding institutions. The authors suggest that the intersection of rangeland restoration ecology and ecosystem service provision might provide a more effective trigger for support.

### *Landscape restoration, principles and practices*

Many properties in Australia have been under the control of one family since the early days of European settlement. We are fortunate in that one such owner near Armidale has kept detailed records of the management of the family property for the last 65 years and described these experiences in a Keynote Address (Williams 2017). The property suffered massive loss of trees during the 1970s and early 1980s as a result of New England dieback. A feature of this farm's management planning was the early provision of a fixed amount of finance as a business investment for the replacement of lost trees. As with most farm management, things changed over the years and this paper is a fascinating record of the changing fashions in ecosystem use and restoration over the last 65 years on the Northern Tablelands of NSW.

The next three papers deal with principles involved in the restoration of degraded landscapes in this region in this day and age. It is by no means possible to cover this whole topic in just three papers, but taken as a group, these papers give an outstanding picture of the changes that have recently occurred in concepts related to ecosystem restoration as the realities of climate change and the critical loss of ecosystem services from complex plant and animal communities have become apparent.

Prober *et al.* (2017) proposed a palate of five principles as guides for goal-setting for nature conservation and ecological restoration. The first principle for this goal setting is to 'optimise ecological process and functions' which is dependent on the second, 'maintaining the ongoing evolutionary potential in the world's biota'. The remaining three are to 'minimise native species losses', while maintaining 'the evolutionary character and biogeographic structuring of the biota' and to 'maintain wild natural ecosystems'. Applying these principles to actual conservation and ecological restoration initiatives may sometimes be difficult, but connecting directly with these basic motivations will help take us forward in a rapidly changing world.

How to provide adequate seed supplies for native vegetation restoration is a difficult topic, particularly for many native Australian species and is addressed in the next paper (Broadhurst *et al.* 2017). As described in this paper, the usual practices for restoration of native Australian vegetation involve either tube stock or direct seeding. We also rely on a small number of species for the majority of restoration projects with the assumption that the remainder of the original flora will re-appear over time. However, these species are often chosen on the basis that they occur naturally in the region and that either tube stock or seed supplies are available commercially. The number of species for which these are available is generally very limited in any particular region. Little or no account is usually given as to whether or not the pollinators necessary for these plants to produce viable seed are present at the site (Gross 2017). A further complication is that the diverse array of species necessary as food plants for larvae, shelter and other requirements for the pollination of sown species may not be present so that these populations cannot maintain themselves over time (Gross 2017). Pollinators are not a problem if Australian native grasses are involved, because these are either wind-pollinated or have a range of breeding systems where cross-fertilisation is not essential for the maintenance of populations (Groves and Whalley 2002).

### *Exotic species invasions*

Human invasions always bring with them many plants and animals when they enter new territories such as Australia (Fleming *et al.* 2017). Some of these are deliberate introductions that are of benefit to humans but others are 'passengers' that are pre-adapted to their new environment, but are detrimental to the new environment and human activities. These plant and animal invasions are accelerating with globalisation and the growth of the human population in Australia, and represent a collision between the Laurasian domesticated taxa with the ancient Gondwanan ecosystems (Fleming *et al.* 2017). This paper reviews some of the theoretical underpinnings of the science of invasive species and outlines a practical working framework for their management.

The propensity for humans to carry invasive species with them is well illustrated in the history of human activities in the Antarctic region, which is one of the most inhospitable regions on earth for weed invasion and still over 100 non-native vascular plant species have become established on the sub-Antarctic islands (Sindel *et al.* 2017). There are only three weeds that are well established on Macquarie Island, *Poa annua* L., *Stellaria media* (L.) Vill. and *Cerastium fontanum* (Baumg), and of these, *P. annua* is the most abundant. This second paper on exotic species invasions presents a fascinating story of the difficulties of studying weed management in an inhospitable environment where safety of the researchers is of primary importance. In addition, little is known about the size and longevity of the seed banks of these three species. There is the same level of ignorance about the off-target impacts, persistence and movement of standard herbicides (Sindel *et al.* 2017). Finally, at least some of the local fauna have no fear of humans and are very curious about the activities of the scientists in their domain (see illustrations).

### *Environmental regulation in Australia and where to from here?*

Rural populations in Australia are an independent lot and often have scant respect for rules and regulations made in the vastly more settled environments of the major metropolitan centres. The result is that when change is perceived necessary to preserve or restore degraded landscapes, rural law is often not effective in changing behaviour (Martin and Hine 2017). Effective action in controlling invasive plants and animals often requires concerted, cooperative and expensive actions among people who may have widely different attitudes and motivations. Martin and Hine (2017) investigate the use of contemporary psychological methods to identify groups of landholders who will respond to different mixes of regulations, incentives and community action. They advise that the aim should be to frame the requirements and regulations delivered to different groups which are sympathetic to each group's needs and these people are then more likely to respond positively to the need for specific restoration goals.

The final paper reminds us that the world is changing rapidly and expectations of what was appropriate for restoration and revegetation 50 years ago, may have evolved (Hobbs 2017). In addition, motivations for undertaking restoration vary through time, as do the resources available to achieve it.

Technology is improving all the time and restoration that is not possible now may change in the future. It is important to recognise the challenges facing conservation and restoration now and into the future throughout the world.

### Conclusions

We believe that the sentiments embodied in the Armidale Declaration provide future direction to not only governments, but anyone involved with the use of the landscape. These sentiments were supported, not only by the papers in this Special Issue, but also by many others presented at the Conference and in the subsequent formal and informal discussions. It is our hope that those in authority at different levels in Australia take note of these findings and endeavour to provide the facilities and the personnel to preserve our unique and precious Australian environment.

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