Recent initiatives in biodiversity conservation in grazed temperate grasslands and woodlands in Australia

Ian Lunt[1] , *John Morgan*[2] , *Louise Gilfedder*[3] , *Richard J . Williams*[4] , *Simon Foster*[5]
[1] *Charles Sturt University , PO Box 789 , Albury , NSW 2640 , Australia . E-mail : ilunt@ csu .edu .au ;* [2] *Department of Botany , La Trobe University , Bundoora Victoria 3086 , Australia ;* [3] *Department of Primary Industries and Water , GPO Box 44 Hobart Tasmania 7001 , Australia ;* [4] *CSIRO Sustainable Ecosystems PMB 44 Winnellie NT 0822 , Australia ;* [5] *Bloomfield , Ross Tasmania 7209 , Australia .*

Key points : Considerable efforts are being devoted to conserving biodiversity within grazed temperate grasslands and woodlands in southern Australia . These efforts include : legislation to prevent further clearance of remnant vegetation , protection of high quality woodland remnants in formal reserves on public land and under property agreements on private property , land purchase and purchase of development rights , and a range of educational and incentive programs to encourage landholders to implement biodiversity-sensitive grazing strategies . The major threats to biodiversity in grazed grasslands and woodlands are soil fertilisation , ploughing/tillage and conversion to non-indigenous pasture species and crops , heavy set stocking , irrigation , and habitat fragmentation resulting in small , isolated populations . Increasingly , attention is being devoted to identifying circumstances in which continued grazing can play a positive role in maintaining biodiversity within conservation areas (especially in degraded ecosystems) and to developing strategic grazing regimes to promote native perennial species above exotic annual species in native pastures . Conservation approaches have shifted from a focus on protected areas to conservation through active use , with market access providing the incentive . Considerable research and development is required on all of these issues .

Key words : conservation , native pastures , grazing , incentives , market-based approaches .

Introduction The conservation of natural values and their continued sustainable use is one of the major issues currently facing the world . Lowland temperate grasslands , steppes and prairies are one of the most endangered natural ecosystems on a global scale , and in Australia they have been reduced in extent to $<1\%$ of their former range (Kirkpatrick et al . 1995) . Temperate grasslands and grassy woodlands were originally widespread in south-eastern Australia , occurring on fertile soils , in flat to gently undulating landscapes receiving 350-800 mm average annual rainfall (Kirkpatrick et al , 1995 ; Hobbs & Yates , 1999) . Treeless grasslands were originally more restricted in distribution than grassy woodlands , but the grassy ground layer of both ecosystems was similar in structure and composition . Ground vegetation was originally dominated by C3 and C4 tussock-grasses (or bunch-grasses) , particularly *Themeda triandra* and *Poa* species , with many low shrubs and forbs (non-graminoid herbs or wildflowers) including many species of daisies and lilies . Little is known of original disturbance regimes , but temperate grassy ecosystems are thought to have been grazed at relatively low levels by native herbivores (e .g . kangaroos) and to have been burnt frequently by lightning and indigenous peoples (Yates & Hobbs , 1997 ; Fensham , 2003) . Many of the unique soft-footed Australian marsupials and the indigenous Aboriginal people dug for plant roots as foods , providing a significant ecological function .

Following European colonisation of Australia in the 1800s , grassy ecosystems were rapidly and extensively used for livestock grazing and converted to agricultural crops . Pasture productivity was boosted by the widespread introduction of fertilisers (especially superphosphate) and exotic pasture species , including grasses and clovers (*Trifolium* and *Medicago* species) , and more recently technological developments have led to increased use of irrigation . The original grassland and woodland regions now support extensive cropping , grazing and mixed production systems . Grazing enterprises range from low input grazing on native-based pastures to high intensity production on irrigated , fertilised exotic pastures . Notwithstanding improvements in agricultural productivity , many regions face serious landscape sustainability problems owing to widespread soil acidification , salinity , soil erosion and other land degradation problems . Many plant and mammal extinctions have occurred , and much of the biome is threatened .

Agricultural and pastoral development decimated natural biodiversity patterns , converting landscapes from biodiverse perennial-based ecosystems to species-poor , exotic annual-based crops and pastures . Increasing grazing intensity led to progressive reductions in the diversity of native forbs and the replacement of tall , perennial , summer-growing (C4) native tussock-grasses with small , short-lived , winter-growing (C3) exotic annuals , including grasses (e .g . *Lolium* , *Avena* , *Bromus* , *Vulpia* spp) and clovers (*Trifolium* and *Medicago* species ; Moore , 1973) . Fertiliser addition , in particular , led to substantial reductions in native plant diversity , and few native plants persist in highly fertilised pastures (Dorrough et al . , 2006) . Additionally , widespread clearing of trees and shrubs has removed habitat for many arboreal fauna , including birds , mammals , reptiles and invertebrates .

Grazing for conservation purposes Historically , vegetation ecologists have focussed on the well-documented negative effects of increasing stocking intensities on native plant diversity in native grasslands and woodlands (Moore , 1973) . Increasingly , however , ecologists and land managers are attempting to address two different questions : (1) what are the impacts on biodiversity of removing livestock from areas that have been grazed historically , and (2) if grazing does persist in these areas ,

how should it be undertaken to maximise biodiversity benefits (Lunt et al ., 2007) ?

These questions acknowledge that the conservation values of many grazed grasslands and woodlands may now be relatively stable under current grazing regimes , and removal of livestock could potentially have negative effects on biodiversity values . Potential positive roles for continued livestock grazing in conservation areas include : maintenance of small-scale plant diversity by reducing competitive dominant species , control of exotic species (especially introduced grasses) , and maintenance of open habitat conditions for certain fauna species (e .g . the endangered ground-dwelling bird , the Plains Wanderer , *Pedionomus torquatus* ; Baker-Gabb , 1998) and some rare plants (e .g . the threatened daisy , *Leucochrysum albicans* ; Gilfedder & Kirkpatrick , 1994) .

Potential positive roles for grazing in biodiversity conservation are relevant to a number of policy contexts , including : (a) management of public lands that have been grazed historically , (b) management of new reserves which have been acquired from previous grazing properties , (c) implementing incentive schemes to improve biodiversity values in remnant vegetation on private land , and (d) no net loss scenarios , in which management scenarios need to be developed to promote future gains in biodiversity values to compensate for losses elsewhere .

The potential positive roles for livestock grazing in maintaining conservation values have been highlighted by decisions to retain livestock in a number of new National Parks in south-eastern Australia , as a practical way to maintain biodiversity assets . Whilst maintaining livestock in national parks may be commonplace in Europe and other parts of the world (Bakker , 1989 ; Rook et al ., 2004) , it is a novel approach in Australia , where livestock are typically removed from conservation reserves in order to promote conservation values . In most Australian ecosystems , livestock grazing causes considerable damage to native ecosystems , so there is likely to be limited potential to use livestock grazing as a conservation management tool in most conservation reserves .

The potential use of livestock grazing to promote conservation values in conservation areas highlights a number of weaknesses in our current ecological understanding of livestock impacts on Australian grasslands and woodlands . From a practical perspective , further information is required to : (1) enable reliable predictions of whether grazing retention or removal will most benefit biodiversity values , and (2) develop strategic grazing approaches based on seasonal resting to promote native species above exotic species in degraded ecosystems . A diverse range of grazing strategies is likely to be needed to accommodate the diversity of ecological situations in which livestock grazing may be continued .

On the other hand , future threats to biodiversity conservation in grazed temperate grasslands and woodlands include : (1) intensification of grazing and agricultural land uses , resulting in the replacement of diverse native ecosystems by species-poor exotic-based systems ; (2) nutrient additions , both intentional and unintentional (which also reduce native plant diversity and promote exotics) ; (3) global warming (impacts on interactions amongst native and exotic species under different disturbance and grazing regimes are unknown) ; (4) competition from exotic species , including ongoing commercial development of new cultivars of existing pasture species (e .g . for increased drought tolerance) , plus newly introduced species such as woody fodder species ; and (5) losses of diversity in small populations in fragmented landscapes .

Conservation policies and practices Over the past 20 years , biodiversity conservation in agricultural production landscapes has received increasing public and political attention . This has led to an increasingly diverse range of policy and practical approaches to conserve biodiversity and regional sustainability . Biodiversity orientated practices are based upon a number of ecological principles : increases in soil fertility reduce native plant diversity and promote exotic species (to the detriment of biodiversity conservation) ; introduced exotic pasture species compete vigorously against native species , and diminish rather than promote biodiversity ; and reductions in total stocking levels by resting pastures can promote dominance by perennial , native species (and sometimes also promote profitability) .

Conservation attention initially focussed on reserving relatively large woodland patches ($>$ 1000 ha) on public land within national parks and other conservation areas , and removing degrading processes such as livestock grazing from these reserves . Increasingly , high quality remnants on private land have been acquired by government and NGOs and added to the national park system in an attempt to create a comprehensive , adequate and representative system of conservation reserves . However , formal conservation reserves on public land still occupy a very small proportion of most grassland and woodland regions ($<$ 5% by area) .

Under National and State threatened species legislation , many woodland ecosystems and species are now listed as threatened with extinction , and destructive processes such as tree clearance are now controlled by regulation . Vegetation clearance legislation has greatly reduced clearing of trees and other woody vegetation in most regions , but has proven difficult to implement in treeless grasslands (i .e . native-based pastures or natural grasslands) .

Additionally , a broad range of incentive-based policies have been introduced to encourage biodiversity conservation on private , production properties . These include government subsidies to help landholders plant perennial native vegetation (mostly at very

small scales) , fence remnants (to control livestock access) , and to promote informal reserve networks on private property (Fitzsimons & Wescott , 2005) . In the past 5 years , no net loss policies have received increasing attention (Parkes et al . , 2003) . These require any destruction of native vegetation to be compensated for by improvements in ecological condition elsewhere on a property . A common technique to improve vegetation condition is to change grazing strategies , for example by replacing set stocking with seasonal resting .

Within grazed native pastures , many extension programs have been undertaken to increase adoption of grazing systems which enhance the proportion of perennial species in pastures rather than annual exotics (e .g . Simpson & Langford , 1996 , Mokany et al . , 2006) . These approaches are often driven by the need to enhance perenniality in order to lower soil water tables to control salinity , but can benefit biodiversity where native perennials are utilised . However a continuing tension exists between the promotion of exotic perennial systems and the retention or promotion of native perennial species . Potential future policy approaches to further enhance biodiversity conservation in grazing systems include the introduction of incentive payments for farmers to run-down soil nutrient levels (phosphorus and nitrogen) , thereby reducing dominance by exotic species and potentially enhancing the establishment of native plant species and fauna habitat .

Innovative new approaches to conservation Regulation has traditionally been the instrument of choice for governments seeking to achieve conservation outcomes , but does not work well where subtle management changes can lead to large differences in conservation success . More recently in North America , innovative conservation partnerships between business , landowners and government have sought to achieve outcomes that remain difficult to achieve through regulation (Ginn , 2004) . These approaches rely on trust being built into the system (Sayre 2005) .

Most lowland temperate grasslands are on private land and form natural pastures for sheep and cattle enterprises (meat and wool) . Many grassland landholders see themselves as custodians of nationally important biodiversity but believe that if they are to protect these natural resources and values on behalf of the broader community then conservation needs to become a viable business enterprise , and needs to give recognition and respect for their farming traditions . In addition , landholders are increasingly identifying that if they are to provide environmental services for the community in the form of clean water , biodiversity protection , carbon , etc , then the community must be prepared to pay for these services .

Recent conservation efforts on private land have largely focused on facilitating landholder stewardship (Stoneham et al . , 2000) , with financial incentives paid to secure conservation agreements that enshrine sustainable natural resource management . Most approaches to grassland conservation are voluntary and often focus on whole-of-property planning , enabling landowners to negotiate management of natural resources in the context of their whole property . Recent innovations have broadened the approaches to covenanting on commercial agricultural businesses to include fixed-term arrangements , and a shift from strict conservation objectives to allowing more broadly for the sustainable management of natural resources , including biodiversity . The use of outcomes-based approaches to monitor the impact of stock grazing on commercial grazing properties that are to be protected under conservation management agreements has shifted the emphasis away from prescriptive approaches that are a disincentive to many landholders .

Market-based approaches are increasingly seen as an incentive for private landowners to engage in conservation activities , including stewardship payments for the provision of ecosystem services . There are many successful examples in operation (e .g . Ginn , 2005 ; Levitt , 2005) . Recently in Australia new programs have offered a tender-style of approach to securing conservation management , whereby the landowner puts in a sealed competitive bid or tender (Stoneham et al . , 2003) . One such program has successfully conserved significant areas of lowland temperate grassland (Buchan , 2006) .

Work is underway with the wool and cattle industries on environmental accreditation to provide market rewards for good management practices . Consumers worldwide are increasingly asking questions about the environmental credentials of the products they purchase and also want verification of producer claims . Environmental accreditation and eco-labelling of sustainable land management practices , biodiversity protection , animal welfare , wildlife-friendly management practices and organic certifications are some of the emerging schemes , but willingness to pay" is a key factor that will determine the future success of these approaches .

In a new initiative in Tasmania , three farming families have developed an approach to protect some of the best remaining examples of lowland grassland in the state . These farmers wish to formalise a long-term partnership with government to protect their grasslands rather than enter into permanent conservation covenants . They have identified that conservation should provide them with an annual income stream and plan to establish a trust fund to manage conservation investment funds which they hope to attract from both the government and the philanthropic sector , as well as developing an innovative legal instrument that provides an evergreen or rolling agreement for 5 years . This initiative advocates a performance-based approach to conservation management agreements , leaving landholders (rather than governments) to settle how to get the agreed results .

Temperate lowland grasslands and woodlands represent one of the major challenges to biodiversity conservation in Australia , and have triggered the development of many innovative policies and practices aimed at promoting biodiversity conservation in

privately owned , production grazing properties . These novel approaches have great potential to greatly enhance the conservation of these threatened ecosystems .

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