



## **COLLABORATION FOR ENVIRONMENTAL EVIDENCE**

### **SYSTEMATIC REVIEW No. 63**

**WORKING TITLE: HOW DO GRAZING AND FERTILIZATION  
AFFECT COMPOSITION AND CONSERVATION OF PLANT DIVERSITY  
IN AUSTRALIAN TEMPERATE GRASSY EUCALYPT WOODLANDS?**

#### **REVIEW PROTOCOL**

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## COVER SHEET

Title	<b>Working title: How do grazing and fertilization affect composition and conservation of plant diversity in Australian temperate grassy eucalypt woodlands?</b>
Systematic review	<b>N<sup>o</sup> 63</b>
Reviewer(s)	<b><i>Josh Dorrough &amp; Sue McIntyre</i></b>
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Date of most recent SUBSTANTIVE amendment	<i>29th January 2009</i>
Details of most recent changes	<i>Title and primary question modified to reflect suggestions by referees. Additional detail added to background. More explicit summary of proposed framework for data synthesis provided, including modifications to state and transition model to allow examination of reverse transitions and to better separate “press” and “release” experimental data. Table 3 added.</i>
Contact address	<b><i>CSIRO Sustainable Ecosystems, GPO Box 284, Canberra ACT 2601, AUSTRALIA</i></b>
Sources of support	<i>Land &amp; Water Australia (LWA)</i>
Conflicts of interest	<i>None</i>

## 1. BACKGROUND

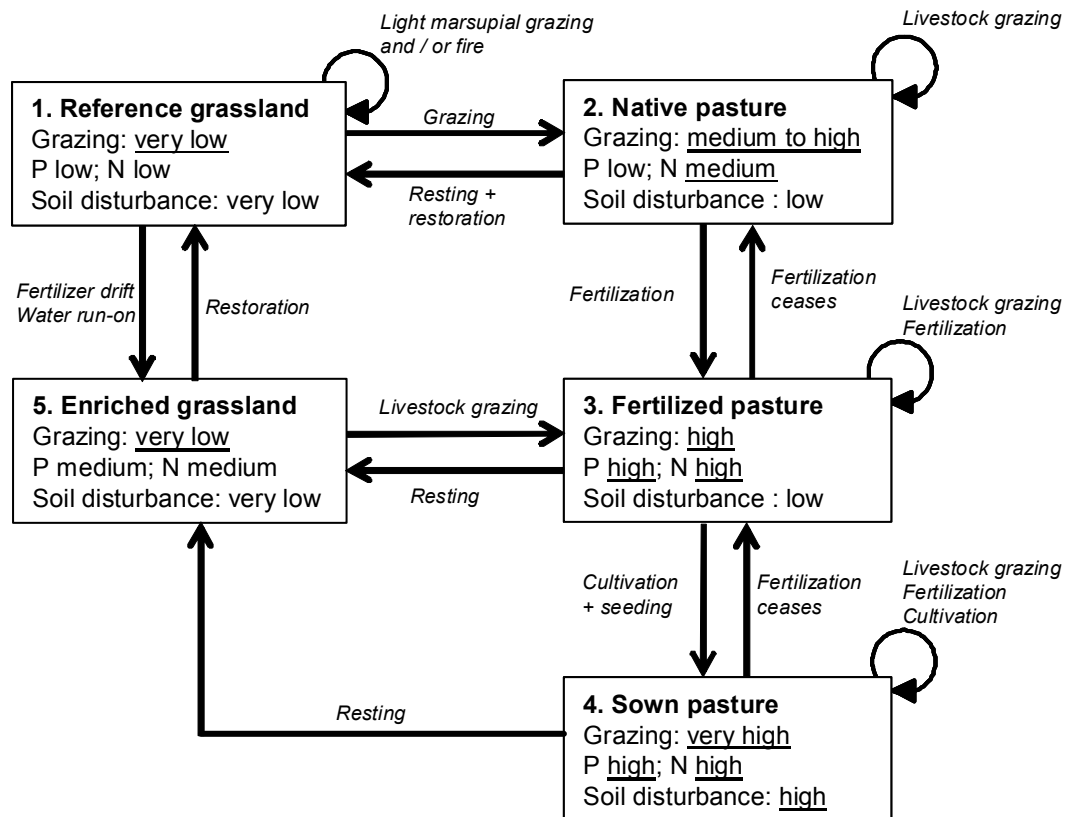
The understorey vegetation of Australia's temperate grassy ecosystems has been substantially modified by a long history of livestock grazing and associated management practices (e.g. fertilization, pasture sowing, cultivation) (Yates & Hobbs 1997; Dorrough *et al.* 2004; Kirkpatrick *et al.* 2005; McIntyre & Lavorel 2007). Temperate grassy ecosystems occur across a range of climates, soils and landscapes throughout south-eastern Australia and with some isolated occurrences in south-western Australia (Yates & Hobbs, 1997). Despite the broad distribution of these ecosystems, management activities such as livestock grazing and fertilization, appear to have relatively consistent impacts on plant species composition (McIntyre & Lavorel 2007). Links between the composition of understorey vegetation, traits of the vegetation and subsequent ecosystem functions have also been identified (McIntyre & Lavorel 2007; McIntyre 2008). These links suggest that there are clear trade-offs between the agricultural production values of the understorey vegetation and environmental attributes such as soil protection and biodiversity preservation. If consistent changes in the composition of understorey vegetation can be identified then predictions can be made for how management will modify conservation values and functional attributes of understorey vegetation.

Most of the remaining temperate grassy vegetation occurs on private lands where livestock production is a major objective for managers. Little of the remaining vegetation is in public managed reserves and there is an interest in the development of management strategies for meeting both conservation and production objectives (Dorrough, Moll & Crosthwaite 2007; Crosthwaite *et al.* 2008). In some cases government financial incentives and stewardship payments are available to managers to help meet these objectives. On public lands, where conservation outcomes are preeminent, there is increasing evidence that in some cases livestock grazing can be a cost-effective management tool (Lunt *et al.* 2007a). In both the public and private land cases managers and investors desire information to identify management regimes for maintaining current plant diversity, and to restore plant diversity. Relief from grazing is often thought to be an important management intervention, but the effects of destocking on vegetation will vary particularly owing to vegetation productivity, historical grazing impacts and current vegetation composition (Lunt *et al.* 2007a). Varying the intensity, frequency and season of livestock grazing and the levels of fertilization are the primary strategies available to private land managers. Reducing available nutrients can also be essential for restoring plant diversity (Prober *et al.* 2005), particularly in areas subject to previous fertilization.

There has been a quantitative review of plant responses to livestock grazing within Australia (Vesk & Westoby 2001) and data from Australia's temperate grassy ecosystems was included in a recent meta-analysis of global effects of grazing on vegetation (Diaz *et al.* 2007). A review of the potential effects of grazing exclusion on plant diversity has also recently been published (Lunt *et al.* 2007). Vesk & Westoby (2001) identified inconsistencies in plant responses to grazing but did not examine interactions with soil enrichment. Diaz *et al.* (2007) also ignored potential interactions with soil enrichment through fertilization. Lunt *et al.* (2007) did consider how the effects of grazing exclusion on vegetation may vary according to soil nutrient enrichment but did not undertake a quantitative assessment of available literature.

A systematic review methodology (Pullin & Stewart 2006) will be used to examine the effects of different levels of grazing and fertilization on plant composition in Australian temperate grassy ecosystems. Discussion with government investors and land management agencies also indicates a strong desire for quantitative evidence about the effects of various interventions on the direction and rate of restoration in grassy ecosystems. There is considerable interest in how ground layer plant diversity responds to relief from grazing and/or fertilization.

Variation in land use practices and management histories is expected to impose considerable complexity on the assessment of evidence. For this reason we propose to use the land use categories described by McIntyre and Lavorel (2007) as an organising framework for the review (Figure 1) but exclude sown pastures (State 4). We also include two additional land use states to enable us to differentiate states that were the result of reverse transitions, that is to differentiate (a) excluded native pastures from reference grasslands (transition 2-1) and (b) past fertilized pastures from native pastures (transition 3-2). Using this framework we will treat the two key interventions of livestock grazing and fertilization, in their binomial form.



**Fig. 1.** State and transition model for understory vegetation in temperate grassy ecosystem showing key management interventions (from McIntyre and Lavorel, 2007)

## 2. OBJECTIVE OF THE REVIEW

The objective of the review is to determine the effect of different levels of grazing and fertilization on plant species composition in Australian temperate grassy ecosystems. Studies will be placed within the organising framework of a modified form of the state and transition model of McIntyre and Lavorel, 2007. To fully capture the effects of management history on vegetation, an additional two states will be included. These are *Exclosed Native Pasture*, an alternative state to *Reference Grassland* but one with a prior history of livestock grazing, and *Past Fertilised Pasture*, an alternative state to *Native pasture*.

### 2.1 Primary question

How do grazing and fertilization affect groundlayer plant composition in the temperate grassy woodland biome?"

### 2.2 Secondary questions

Conservation managers currently desire information to inform decision making about whether or not to provide incentives for relief from grazing and/or fertilization. A secondary question of particular interest to managers is "How does ground layer plant diversity/composition respond to relief from grazing and/or fertilization?"

Table 1 outlines the subject, intervention, outcome and comparator.

**Table 1 Question elements and their description**

Question Element	Description
Subject	Individual plant species and their classifications into plant functional groups in temperate grassy ecosystems of Australia
Intervention	Livestock grazing, nutrient enrichment/fertilization separately and in combination (see Fig 1).
Outcome	Change in, or measure of, the frequency, biomass or cover of individual species
Comparator	No (limited) grazing, no fertilizer (Reference Grassland in Fig. 1)

## 3. METHODS

### 3.1 Search strategy

#### a. *Electronic databases*

The following electronic databases will be searched:

1. ISI Web of Knowledge
2. Directory of Open Access Journals
3. Scirus
4. ScienceDirect
5. Agricola
6. Australian Agriculture and Natural Resources Online (AANRO)
7. Australian Natural Resources Index
8. Australian Natural Resources Index Archive

9. Agris
10. Cambridge Scientific Abstracts (CSA) – Natural Sciences
11. Australian Digital Theses Program

Searches will also be undertaken using the internet-based search engines Google Scholar and WebPlus. The first 100 word document or PDF hits from each data source will be examined for appropriate data.

General search terms were developed (see below). Preliminary searches indicated that several of these are likely to yield large result sets. In these cases study exclusion terms will be used with “NOT” statements (e.g. NOT tropical, NOT arid), where the database allowed for this.

#### Subject only

1. Grass\* & Woodland\* & Australia
2. Temperate & Grass\* & Australia
4. Botanical composition & Woodland & Australia
5. Temperate & Pasture\* & Australia OR NSW, Victoria, Tasmania, South Australia

#### Intervention and subject

1. Plant\* & Graz\* & Australia
2. Vegetation & Graz\* & Australia
3. Pasture & Graz\* & Australia
3. Plant\* & Nutrient\* & Australia
4. Vegetation & Nutrient\* & Australia
5. Plant\* & Fertil\* & Australia
6. Vegetation & Fertil\* & Australia
7. Pasture & Fertil\* & Australia
8. botanical composition & Fertil\* & Australia
9. botanical composition & Graz\* & Australia

#### ***b. Specific Authors***

Our previous collective examinations of the literature have identified a number of potential key authors (listed below). We will search Web of Science for each of these authors using the author field tag (i.e. to exclude multiple citations).

Allcock, K.G  
Badgery, W. B.  
Benson, J. S.  
Biddiscombe, E.F.  
Boulton, A.  
Bridle, K. L.  
Bruce, S.  
Chalmers, A. C.  
Chapman, D. F.  
Chilcott, C.

Clarke, P. J.  
Cole, B. I.  
Davison, E. A.  
Doing, H.  
Dowling, P. M.  
Eldridge, D. J.  
Facelli, J. M.  
Fensham, R. J.  
Foreman, P. W.  
Fox, M.  
Frood, D.  
Garden, D. L.  
Gibson, N.  
Gilfedder, L.  
Groves, R. H.  
Hamilton, S.  
Hyde, M. K.  
Kemp, D. R.  
King, W. M.  
Kirkpatrick, J. B.  
Lange, R. T.  
Langford, C. M.  
Leigh, J. H.  
Li, J.  
Lodge, G. M.  
Lunt, I. D.  
Magcale-Macandog, D. B.  
Michalk, D. L.  
Moore, R. M.  
Morgan, J. W.  
Munnich, D. J.  
Nott, R.  
Odgers, B. M.  
Parsons, R. F.  
Petit, N.  
Prober, S. M.  
Rehwinkel, R.  
Reid, N.  
Reseigh, J.  
Robinson, B. B.  
Rodgers, R. W.  
Roe, R.  
Scarlett, N. H.  
Semple, W. J.  
Simpson, P. C.  
Stuwe, J.  
Trémont, R. M.  
Whalley, R. D. B.  
Williams, O. B.

In addition known active researchers will be contacted with a request for refereed manuscripts in press and Masters or PhD theses relevant to the review topic.

### ***c. Existing libraries***

We also have compiled extensive personal lists of research papers and theses. These will be scanned for additional references that meet the study inclusion criteria.

Bibliographies of all articles viewed at full text will be searched.

### ***d. Specific journals***

The table of contents of all issues of the following journals will also be searched for possible relevant studies:

Australian Journal of Experimental Agriculture  
Australian Journal of Agricultural Research  
The Rangeland Journal  
Pacific Conservation Biology  
Cunninghamia

## **3.2 Study inclusion criteria**

### **• Relevant subject(s):**

Relevant subjects are any plant species or plant functional groups that occur in the understory / ground layer of temperate grassy ecosystems. We will take a relatively broad interpretation of what comprises the geographic boundaries of the temperate woodlands, including studies from the E1 (Mediterranean), E2 (dry Mediterranean), E3 (mostly summer dominant growth), D5 (cool, dry) and F3 (warm, wet summer) agro-climates of Hutchinson *et al.* (2005). This excludes studies from the tropics, arid and alpine zones.

We recognise that in many circumstances there will be difficulties in determining whether a study specifically applies in terms of the vegetation envelope. Native and sown pastures can be derived from woodlands, grasslands or forest. Further, tree structural attributes (cover, density and height) are dynamic and spatial and temporal gradients between grassland, woodland and forest boundaries can increase difficulties regarding delineating the appropriate ecosystem. Additionally a number of studies collectively examine grassy ecosystems, and include cleared woodland, grassy woodland, grassland, and grassy forest. The search will exclude research in wet forests, wetlands (and associated vegetation types such as sphagnum bogs, sedgeland), heathlands and dry sclerophyll forests with a shrub dominant understory. A further complication is the dynamic nature of shrub cover in many grassy ecosystems. Shrub invasion into temperate grasslands and woodlands is widely described in the literature, typically post relief from grazing and fire (eg. Costello, Lunt & Williams 2000). Studies that provide evidence of recent shrub invasion into grassy dominated temperate ecosystems will provide the exception to the rule of current grassy dominance.

### **• Types of intervention:**

Primary interventions are nutrient enrichment and commercial levels of livestock grazing. This includes sheep and cattle grazing but excludes goat, horse, native animal or feral animal grazing. Nutrient enrichment can be either through fertilizer

input (most frequently in the form of superphosphate with the introduction of exotic annual legumes for the fixation of nitrogen), enrichment through livestock camping or nutrient run-on. This excludes atmospheric soil nutrient enrichment. Where possible, levels of enrichment and grazing will be assigned. Current knowledge of the literature suggests that categorical descriptions based on land use are most prevalent and these tend to correspond to the six land use states in the model (Fig. 1). Often land use descriptions include information about both fertilization and grazing (see Table 2)

**Table 2. Relationships between land use descriptions and interventions**

Land use	Intervention
Native pasture	+ grazing, never enriched
Fertilized pasture (incl. livestock camping)	+ grazing, + enrichment
Exclosed native pasture	Ex grazing, never enriched
Enriched grassland	+ enrichment, ex grazing
Past fertilised/Degraded pasture	+ grazing , past enriched

To address the secondary questions that relate to relief from grazing or fertilization, the previous land use state provides the necessary context for analysis of the intervention (eg. Table 3). We will also contrast the vegetation responses across the restoration transitions with their reverse transitions (Table 3).

**Table 3. Interventions, and current and prior land use for analyses for state transitions owing to grazing and/or fertilization**

	Prior Land use	Intervention	Current Land use
<i>Restoration Transitions</i>			
	Native pasture	- grazing, - enrichment	Exclosed native pasture
	Fertilized pasture	- grazing, + enrichment	Enriched grassland
	Fertilized pasture	+ grazing, - enrichment	Past fertilised
<i>Disturbance Transitions</i>			
	Reference Grassland	+ grazing, -enrichment	Native pasture
	Native Pasture	+grazing, +enrichment	Fertilised pasture
	Reference Grassland	- grazing, +enrichment	Enriched grassland

- **Types of comparator:**

Long-term relief from commercial levels of livestock grazing and absence of fertilization. However, studies providing information on the subject for any combination of the interventions will also be included even if they do not contain a comparator.

- **Types of outcome:**

Studies need to include measures of, or changes in, individual species or plant functional group cover, biomass or frequency. Studies that only report indices of diversity or richness will be excluded. The exception will be in cases where the raw data used to develop the indices can be obtained from the author/s.

Two distinct types of study outcome were identified *a priori*. Firstly, summaries of vegetation composition and relative abundance, for a specific land use state. In these cases the five most abundant species were ranked where sufficient data were available. Up to twenty additional species were recorded as not dominant. The

second type of study provides information regarding the response of individual species to transitions between land use states. For these studies species responses will be classified as either positive, neutral or negative.

- **Types of study:**

Studies must include raw data or summaries of raw data - qualitative assessments based on supposition or personal/collective experience will be excluded.

Species composition data are likely to typically conform to two types: (1) summaries of species composition and relative abundances and (2) modelled responses of species to interventions are provided. Both forms of data will be accepted.

We will limit our search to peer-reviewed data for quality control purposes and due to time and resource constraints. Thus we will include refereed journal articles and externally examined theses (Masters and PhD). Unpublished reports and conference proceedings will be typically excluded unless already held by the authors and with a study quality of II-2 (see 3.4 below). Raw data sets were accepted only if they formed the basis for peer-reviewed manuscripts.

- **Potential reasons for heterogeneity:**

There are numerous possible reasons for heterogeneity. These include variation in:

1. Type of grazing animal and variation over time.
2. Grazing intensity
3. Grazing season and frequency
4. Spatial variability of nutrient enrichment
5. Type of fertilizer (e.g. single super phosphate, rock phosphate, urea) or dominant nutrient (e.g. nitrogen, phosphorus, potassium)
6. Method of enrichment (e.g. run-on, fertilizer, livestock accumulation)
7. Landscape position
8. Tree cover
9. Pasture sowing history
10. Spatial scale of the study
11. Recent rainfall, soil moisture, drought
12. Time since fertilization
13. Soil disturbance
14. Soil/substrate

### 3.3 Study quality assessment

Articles that meet study inclusion criteria will be assessed at full text stage according to a hierarchy of evidence developed by Pullin & Knight (2003) (see Table 3). Only studies assessed as having a quality of **I - II-3** will be retained in the review.

**Table 4. Hierarchy of evidence based on the experimental design of research undertaken. From Pullin and Knight (2003).**

Quality of evidence – Conservation	
<b>I</b>	Strong evidence obtained from at least one properly designed; randomised controlled trial of appropriate size.
<b>II-1</b>	Evidence from well designed controlled trials without randomisation.
<b>II-2</b>	Evidence from a comparison of differences between sites with and without

	(controls) a desired species or community.
<b>II-3</b>	Evidence obtained from multiple time series or from dramatic results in uncontrolled experiments.
<b>III</b>	Opinions of respected authorities based on qualitative field evidence, descriptive studies or reports of expert committees.
<b>IV</b>	Evidence inadequate owing to problems of methodology e.g. sample size, length or comprehensiveness of monitoring, or conflicts of evidence.

All studies will be assessed by a single reviewer. Studies will be examined by a second reviewer if there is ambiguity about the study quality.

### **3.4 Data extraction strategy**

For each study accepted into the final review, the study characteristics (subject, intervention, and outcomes measured), study quality, sources of heterogeneity, and results (in a format suitable for meta-analysis where possible) will be recorded.

The key metadata that will be recorded for each study are presented in Appendix 1.

### **3.5 Data synthesis**

All quantitative data will be compiled for each species or plant functional group. As identified above this may require separate compilations depending on the type of study. Statistical analyses of data will be undertaken if sufficient studies are obtained.

## **4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT**

None to report. This systematic review is funded by Land & Water Australia.

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## Appendix 1. Study metadata

<b>Study Type</b>	<b>Definition</b>
1	Compositional description (species or functional groups)
2	Modelled responses

### **Grid location**

Latitude  
Longitude

<b>Agro Climate</b>	<b>Code</b>
Cool, wet	D5
Mediterranean	E1
Warm, summer growing	E2
Warm, wet-dry	E3
Sub-tropical wet-dry	E7
Warm temperate wet	F3
Sub-tropical wet	F4
Brigalow	E4
Unknown	U

### **Australian State**

ACT  
NSW  
QLD  
SA  
TAS  
VIC

<b>Bioregion</b>	<b>Code</b>
Victorian Volcanic Plain	VVP
Victorian Midlands	VM
Tasmanian Northern Midlands	TNM
Tasmanian Northern Slopes	TNS
Tasmanian South East	TSE
King	KIN
Flinders	FLI
Ben Lomond	BEL
Eyre York Block	EYB
Kanmantoo	KAN
Murray Darling Depression	MDD
Naracoorte Coastal Plain	NCP
Riverina	RIV
New England Tableland	NET
NSW South Western Slopes	NSS
South East Coastal Plain	SCP
South East Corner	SEC
South Eastern Highlands	SEH
South Eastern Queensland	SEQ
Brigalow Belt South	BBS
Cobar Penepplain	CP
Nandewar	NAN
Sydney Basin	SB

NSW North Coast	NNC
<b>Land Use History</b>	<b>Definition</b>
Cemetery	Or other non-grazed tenure, eg railway reserve
Roadside	Not including Travelling Stock Routes
TSR route or reserve	Determined by tenure only
Native pasture	Commercial grazing no super or cultivation
Reference grassland	Spans a range of land uses but aimed to sample least modified areas
Unknown	Information not available
Fertilized pasture	Super with or without cultivation
Natural pasture	History vague, range from no to some super, mixed histories
<b>Land Use State</b>	<b>S &amp; T Number (McIntyre &amp; Lavorel 2007)</b>
Reference Grassland	1
Native pasture	2
Fertilized Pasture	3
Sown Pasture	4
Enriched Grassland	5
Exclosed native pasture	6
Past fertilized	7
Range	8
Unknown	9
<b>Lithology</b>	<b>Definition</b>
Sedimentary	
Granite	
Basalt	
Alluvial	
Range	Observation spans a range of unspecified substrate types
Unknown	Information not available or in different category
<b>Landscape Position</b>	<b>Definition</b>
Upper	Upper slopes and ridge tops
Mid	Mid slopes
Lower slopes	Lower slopes
Drainage lines	Alluvial, watercourses and sites of internal drainage
Range	Covers more than two positions or an unspecified range of positions
Unknown	Information not available
<b>Sown Legume</b>	<b>Definition</b>
Legumes sown	Deliberate introduction of seed, sowing methods covered under cultivation and fertility
Legumes naturalized or absent	Legumes may have spread naturally but were not sown
Range	Covers sown and unsown sites
Unknown	Information not available
<b>Fertility Rank</b>	<b>Definition</b>
Very low	Ridgetops, eroded slopes, not fertilized, may have naturalized legumes
Low	non-eroding mid and lower slopes with no or very light of old fertilization

Medium	Unfertilized basalt, mod. fertilized sediments and granites with sown legumes
High	Moderately fertilized basalt, alluvium, heavily fertilized sediments and granites.
Extremely high	Basalt or alluvium with heavy fertilization and sown legumes, stock camps
Range	Observation spans range of fertilities
Unknown	Information not available

**Fertilizer and Soil Enrichment**

Total superphosphate  
 Years superphosphate  
 Soil phosphorus (available)  
 Soil nitrogen - Total  
 Soil nitrogen - Available

\*include method of analysis  
 \*include method of analysis

**Cultivation History**

None  
  
 Moderate  
 Severe  
 Range  
 Unknown

**Definition**

No cultivation, or sod seeded  
 Cultivation ceased some time ago or less than three cultivations  
 Frequent and prolonged cultivation  
 Observation spans a range of histories  
 No information

**Soil Disturbance**

Little or none  
  
 Low  
  
 Moderate  
 Severe  
 Range  
 Unknown

**Definition**

Only effects of moderate grazing and small animal diggings, roots undamaged  
 Minor, occasional mechanical disturbance, some damage to rootstocks  
 Recent limited but severe disturbance, chronic minor disturbance, moderate damage to rootstocks  
 Chronic severe disturbance e.g. recurrent cultivation  
 Observation covers a range of levels of soil disturbance  
 Information not available

**Grazing Pressure**

Low  
  
 Moderate  
 High  
 Range  
 Unknown

**Definition**

Highly selective grazing with tall sward structure  
 Selective grazing with lawn, tall patch mosaic or medium sward height  
 Non-selective grazing, lawn structure  
 Spans range of pressures  
 No information

**Livestock Type**

Cattle  
 Sheep  
 Mixed

**Definition**

Mainly cattle - beef or dairy  
 Mainly sheep - all kinds  
 Significant proportions of both cattle and sheep

**Grazing Ranking**

Very low  
 Low  
  
 Moderate

**Grazing Ranking**

Cemeteries, no livestock for decades, may be burnt  
 Occasional livestock e.g. Travelling Stock Reserves  
 Low stocking rates, heavier grazing in past but light now, tall patches

High	Medium commercial stocking rates, medium patches
Extremely high	High, commercial, improved pastures, grazing lawns, livestock camps
Range	Observation covers a range of grazing regimes
Unknown	Grazing pressure could not be determined

**Abundance Index**

Biomass	Could be ranking or actual measurement
Cover	Could be classes or % estimates
Frequency	Presence or absence
Other	Mixed, unknown or not applicable

**Definition**

**Confidence**

Statistical	Statistically significant association
Association	Trend in data (e.g. through judgement or multivariate analysis), but no statistical analysis.
Other	Mixed, unknown or not applicable

**Definition**

**Study Quality Rank**

<b>I</b>	<b>Definition</b> Strong evidence obtained from at least one properly designed; randomised controlled trial of appropriate size.
<b>II-1</b>	Evidence from well designed controlled trials without randomisation.
<b>II-2</b>	Evidence from a comparison of differences between sites with and without (controls) a desired species or community.
<b>II-3</b>	Evidence obtained from multiple time series or from dramatic results in uncontrolled experiments.
<b>III</b>	Opinions of respected authorities based on qualitative field evidence, descriptive studies or reports of expert committees.
<b>IV</b>	Evidence inadequate owing to problems of methodology e.g. sample size, length or comprehensiveness of monitoring, or conflicts of evidence.

**Study Methodology**

Experimental manipulation	Grazing and or enrichment levels manipulated experimentally
Land tenure comparison	Survey of sites with known history of land management, comparison of vegetation among differing tenure. Include cross-fence comparisons

**Data recorded for each species or plant functional group**

**Species Dominance**

1, 2, 3, 4, 5,	<b>Definition</b> List up to five dominant species
ND	Not dominant
NI	No information

**Pattern**

Characteristic	<b>Definition</b> Characteristic of that treatment but other treatments also typically have higher abundance of this species
Defining	Abundance peak only in that treatment (i.e. one observation of n observations in a paper)
na	Not applicable (e.g. if there is only one observation per paper)

nil No information (e.g. for species you want to list but only have vague information about their presence)

**For response summary data types the following additional data will be recorded for each species/functional group**

<b>Intervention contrast/transition</b>	<b>Transitions</b>
Grazing	1 to 2
Fertilization	2 to 3
Enrichment Only	1 to 5
Grazing and fertilization	1 to 3
Exclosure - enriched	3 to 5
Exclosure - no enrichment	2 to 1
Nutrient run-down	3 to 2

**Response direction**

Negative  
Neutral  
Positive