NEW HOPE GROUP

J.8 Bluegrass Offset Management Plan

NEW HOPE GROUP

BLUEGRASS OFFSET MANAGEMENT PLAN

New Acland Coal Mine Stage 3 Project

JANUARY 2014

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1. Introduction

1.1. Revised Project

New Acland Coal Pty Ltd (NAC) currently operates the Mine, as a 4.8 million tonnes (product coal) per annum (Mtpa) open cut coal mine on Mining Lease (ML) 50170 and ML 50216 within Mineral Development Licence (MDL) 244, under the approval of Environmental Authority (EA) No. EPML00335713. The Mine is forecasted to deplete its reserves by 2017. The revised Project involves the extension and operation of the Mine, increasing production from 4.8 Mtpa up to 7.5 Mtpa of thermal product coal.

The revised Project involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within MLA 50232. These resources areas are termed the Manning Vale and Willeroo resource areas. The revised Project will include mining in three new mine pits, namely, the Manning Vale West, Manning Vale East and Willeroo mine pits.

The key objectives of the revised Project are to:

- establish and operate a sustainable and profitable coal mine;
- construct and operate a mine that complies with all relevant statutory obligations and continues to improve operations to ensure best practice environmental management;
- construct, design and operate a mine that does not compromise environmental and social indicators and standards;
- make efficient use of current infrastructure, with upgrades and expansions for the required capacity increase;
- reduce the disturbance to environmental values by minimising the footprint requirements for road and rail construction and the use of areas already disturbed for laydown and storage and handling facilities; and
- use similar proven strategies to those adopted at the Mine, for example:
  - salvage and stockpiling of topsoil;
  - early and progressive rehabilitation of disturbed areas;
  - use of recycled water as the main water supply;
  - protection of water quality by appropriate management systems; and
  - adoption of appropriate landform designs to ensure sustainability and planning for a nominated final land use.

In addition, the key features of the revised Project will include the:

- development of a suitable 'off set' strategy to satisfy State and Federal requirements for clearance of significant vegetation within new operational areas (i.e. extent of surface rights areas) on MLA 50232;
- preservation of historical items within Acland;

- comprehensive progressive rehabilitation program involving continuous monitoring and reporting in line with the agreed post mining land use; and
- amendment of NAC's existing EA commensurate to the revised Project's size and scope.

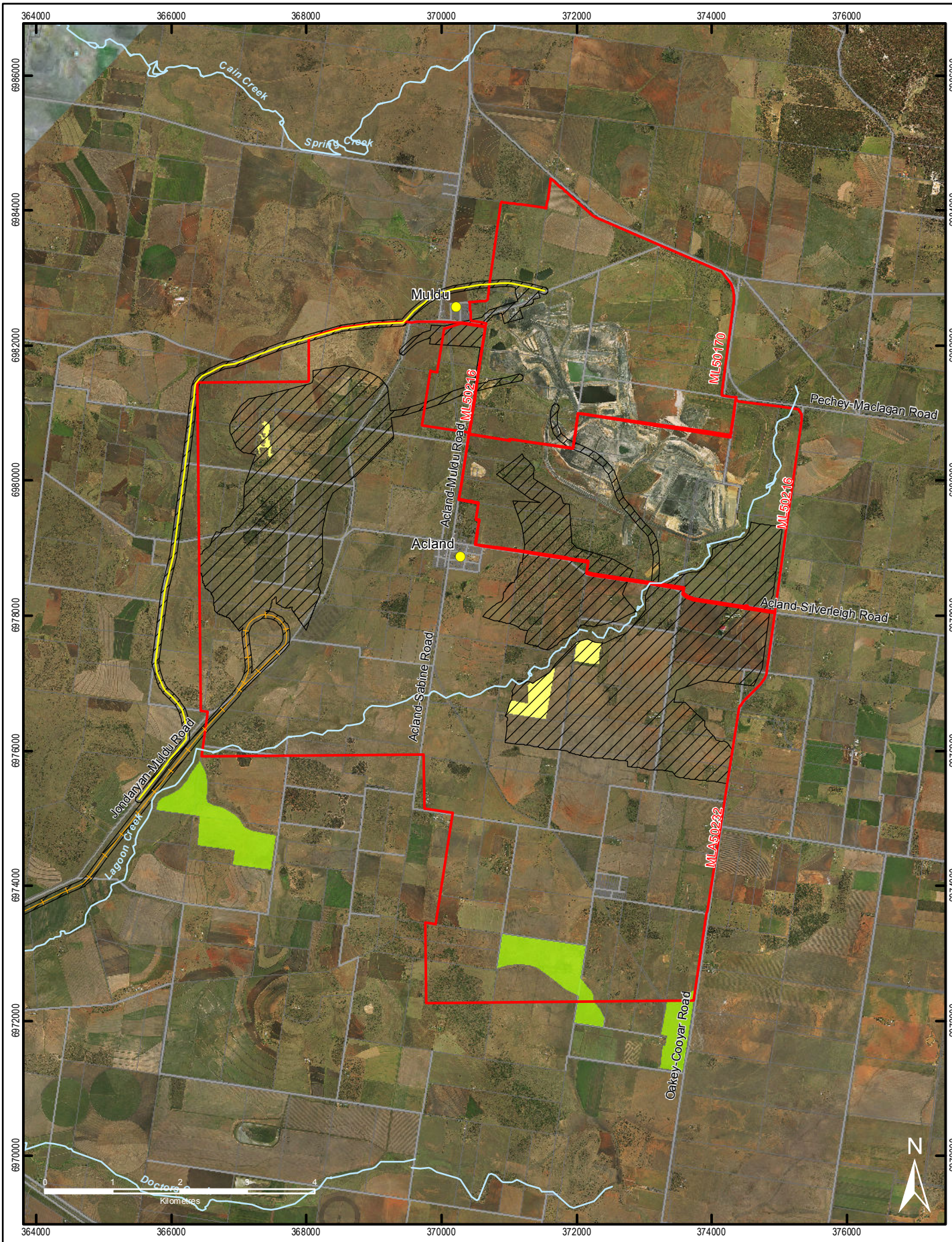
1.2. Background, purpose and scope of plan

The Bluegrass Offset Management Plan (BOMP) has been developed as an environmental offset requirement for areas of Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregion (North and South) endangered ecological community (Bluegrass ecological community) residually impacted by the revised Project. Bluegrass ecological community areas (patches) within the revised Project site were assessed during the *New Acland Stage 3 - Baseline Environmental Study* (SKM, 2007) and these patches were re-assessed by Sinclair Knight Merz (SKM), post wet season, on 9 and 10 February 2011 and in August and September 2013. The BOMP is based on providing environmental offsets for areas of the Bluegrass ecological community that meet the historical listing advice identified in the Bluegrass re-assessment (SKM, 2011; Appendix A). Based on the findings of the re-assessment, there is a residual impact totalling 40.1 ha on the Bluegrass ecological community comprising of 4.2 ha of Regional Ecosystem (RE) 11.8.11 (*Dichanthium sericeum* grassland on Cainozoic igneous rocks) and 35.9 ha of non-remnant RE 11.3.21 . Figure 1-1 shows the area of Bluegrass ecological community impacted by the revised Project and potential Bluegrass offset locations.

The Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) indicates that the offset needs to be provided for residually impacted areas of the Bluegrass ecological community – as defined by the historical listing advice – and the area required for residually impacted Bluegrass ecological communities should meet the '10 Offset Principles' of the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (SEWPaC, 2012) and under normal circumstance provide a minimum 'direct' offset of 90 per cent. The BOMP addresses SEWPaC's requirements while providing indirect offset options consistent with the Draft Recovery Plan for the "Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)" endangered ecological community (Bluegrass Recovery Plan) (Butler, 2007).

The SEWPaC during January 2009 split the Bluegrass ecological community into two separately listed grassland ecological communities: one for the northern Brigalow Belt (Endangered Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin); and one for the southern Brigalow Belt (Critically Endangered Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland). Ecological condition thresholds were also developed as a result of the redefinition of the community. However, SEWPaC has advised that the revised Project's requirements must be determined on the historical condition thresholds (Section 3.3).

The BOMP identifies the location, management objectives, ecological condition and performance criteria for the Bluegrass ecological community environmental offsets. The BOMP proposes an environmental offset consistent with the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the EPBC Act Environmental Offsets Policy (SEWPaC, 2012).



LEGEND

- Towns and Localities
- Rail Spur
- Roads
- Creeks
- Jondaryan-Muldu Road Diversion
- Cadastre
- Mining Tenements
- Disturbance Footprint Area
- Proposed Bluegrass Offset Locations
- Bluegrass dominated grassland

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 1-1 - Bluegrass Distribution and Offset Locations

Scale 1:75,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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2. Legislative Requirements

2.1. Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act prescribes the Commonwealth Government's role in environmental assessment, biodiversity conservation and the management of protected areas. The EPBC Act provides protection for matters of National Environmental Significance (MNES) including:

- world heritage properties;
- national heritage places;
- wetlands of international importance (listed under the Ramsar Convention);
- listed threatened species and ecological communities;
- migratory species protected under international agreement;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park; and
- nuclear actions (including uranium mines).

2.2. EPBC Act Environmental Offsets Policy

The EPBC Act Environmental Offsets Policy (SEWPaC, 2012) or "EOP" aims to deliver improved environmental outcomes which provide the community with certainty and guidance to ensure efficient, effective, transparent, proportionate and reasonable use of offsets under the EPBC Act. There are two types of offsets for residual impacts that cannot be adequately reduced or avoided. Direct offsets provide improved conservation outcomes and on-ground protection for the impacted MNES where indirect offsets aim to improve our knowledge, understanding and management of environmental values leading to improved conservation outcomes for the MNES. The EOP requires proposed offsets to:

- deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action;
- be built around direct offsets but may include other compensatory measures;
- be in proportion to the level of statutory protection that applies to the protected matter;
- be of a size and scale proportionate to the residual impacts on the protected matter;
- effectively account for and manage the risks of the offset not succeeding;
- be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State offsets that may be suitable as offsets under the EPBC Act for the same action);
- be efficient, effective, timely, transparent, scientifically robust and reasonable ;
- have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced;

- be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty; and
- be conducted in a consistent and transparent manner.

3. Bluegrass Offset Management Plan - Direct Offsets

3.1. Overview

The New Hope Group (NHG) will provide direct offsets that include the on-ground protection for existing Bluegrass ecological communities via sustainable management objectives and restoration initiatives for adjacent areas. The offset areas will provide connectivity to a State significant biodiversity corridor which occurs adjacent to the revised Project site on land owned and managed by the Acland Pastoral Company (APC), a company established by the NHG.

The direct offsets will be supported by site-specific management plans and managed by the APC with a locally-based pastoral manager. To protect the offset areas in perpetuity, a suitable legal protection mechanism will be established over the applicable land parcels (e.g. Queensland nature refuge or covenant). Management objectives for the offset areas aim to implement practices that improve the extent and ecological condition of the Bluegrass ecological community. This approach will be achieved through a combination of fencing, stock management, ecological restoration and maintenance works, weed management, performance monitoring, and general management (e.g. administration).

3.2. Location of Offset Areas

Three potential offset areas have been identified on land owned by NAC to the south of the revised Project area. All three potential offset areas possessed evidence of an existing Bluegrass ecological community and *Dichanthium sericeum* regeneration potential, and occurred on the pre-clearing land zones. Site survey results are provided in Appendix B.

The offset areas are located south of the revised Project site and adjacent to a State significant biodiversity area mapped by the DEHP's Biodiversity Planning Assessment (BPA).

The total offset area is 247 ha.

3.3. Assessment of Ecological Equivalence Condition

Both remnant and non-remnant patches are considered part of the Bluegrass ecological community. Offset areas were assessed against the condition thresholds for the historical listing advice for the Bluegrass ecological community, and include:

- REs listed that meet the Bluegrass ecological community:
  - RE 11.8.11, *Dichanthium sericeum* grassland on Cainozoic igneous rocks, on lowlands
  - RE 11.4.4, *Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains
  - RE 11.3.21, *Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains; cracking clay soils
  - RE 11.9.12, *Dichanthium sericeum* grassland with clumps of *Acacia harpophylla* on Cainozoic fine-grained sedimentary rocks;
- The main criterion for condition thresholds is the 50% rule:
  - "Bluegrass communities in which weeds or exotic grasses comprise more than 50% of the total species composition of the vegetation and with the *Dichanthium spp.* occurring only as individual plants or in small clumps are not part of the listed

Bluegrass ecological community. It is important to note however that the relative cover of weeds and abundance of *Dichanthium* plants can also be affected by climatic and other conditions."

The methodology used for on ground ecological assessment of offset areas followed the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al., 2012) in combination with the Biocondition methodology for treeless ecosystems (DERM, 2011).

Survey sites were established in each offset area. Survey results are provided in Appendix B, respectively. Survey results were used to determine the ecological condition for each offset area and to break down offset areas into practical management areas with different management objectives.

3.4. Management Objectives

Each Bluegrass offset area was surveyed and separated into rehabilitation management areas based on the ecological condition and management actions and objectives required to maintain or rehabilitate the Bluegrass ecological community (Error! Reference source not found.). Management areas for each survey location are described as:

- translocation sites;
- assisted natural regeneration areas; and
- bluegrass rehabilitation areas.

Management objectives relate to practices that maintain and promote native perennial grass establishment and the diversity and abundance of the preferred native species within the Bluegrass ecological community offsets areas. A list of preferred species associated with the Bluegrass ecological community, recorded during the Bluegrass re-assessment, is provided in (Table 3-1) (SKM, 2011).

Table 3-1 Bluegrass indicator species and cover ranges

Species	Common Name	Percentage Cover (%)
Panicum decompositum *	Native millet	10-20
Dichanthium sericeum *	Queensland bluegrass	10-70
Aristida leptopoda *	White speargrass	5-10
Austrodanthonia bipartita*	Wallaby grass	5-12
Panicum queenslandicum *	Yabila grass	5-10
Themeda triandra *	Kangaroo grass	5-25
Themeda avenacea*	Oat Kangaroo grass	5-25
*Indicator perennial grass species from listing advice.		

3.5. Translocation sites

Translocation sites will be provided and will include protected and fenced off areas for the translocation of threatened species associated with the Bluegrass ecological community that

will be impacted by the revised Project. The species are identified as Lobed Blue-grass (*Bothriochloa biloba*), Belson's Panic (*Homopholis belsonii*) and Finger Panic Grass (*Digitaria porrecta*). The management of the translocation of these species is described in the revised Project's Threatened Species Translocation Plan.

In addition, prior to the clearance of the identified areas of Bluegrass ecological community to be impacted by the revised Project, significant specimens of the herb and forb species associated with Bluegrass ecological community will be transplanted using the same methodology outlined in the revised Project's Threatened Species Translocation Plan.

3.6. Assisted natural regeneration areas

Assisted natural regeneration areas have been either historically cropped or continuously grazed. *Dichanthium sericeum* ranges from 20–30% cover in these areas and up to three Bluegrass ecological community indicator species have been recorded. These areas however have 30–45% bare earth and require control of pasture weeds. The management objective for assisted natural regeneration areas is weed control and wet season spelling from grazing until the bare ground cover percentage is reduced to <10%. This objective is consistent with the Bluegrass Recovery Plan 2.1.1 (Appendix C).

Upon implementation of the BOMP, the following measures will be implemented within the assisted natural regeneration areas.

- These areas will be spelled and weeds controlled using broad leaf herbicide application to avoid impacts on existing native grasses.
- While being spelled and after favourable seasonal conditions, these areas will be direct-drilled with seed collected from local Bluegrass ecological community areas or purchased local seed if available.
- These areas will be monitored pre- and post-wet season i.e. October and March to ascertain the ecological condition in association with the performance criteria.

Once the assisted natural regeneration areas meet the performance criteria for the Bluegrass ecological community they will be managed in accordance with the sustainable grazing areas.

3.7. Bluegrass rehabilitation areas

The management objective for Bluegrass rehabilitation areas is to reduce the non-native biomass by a combination of heavy cattle grazing, ploughing, and if required, the application of broad leaf herbicide. This management regime is consistent with the Bluegrass Recovery Plan 2.1.2 (Appendix C). Bluegrass rehabilitation areas incorporate areas that have been historically cultivated and areas that have been sown to introduced pasture.

Site based action plans will be developed for each Bluegrass rehabilitation area including on-ground biomass reduction of non-native perennials, seed collection, site preparation, planting, monitoring, replanting, weed control and on-going management. Upon acceptance of the BOMP, the following measures will be implemented.

- Sites for replanting will be prepared for sowing after initial biomass reduction and weed management.
- Seed for replanting will be harvested from areas of known Bluegrass endangered ecological community and/or purchased if available to make up any short falls in seed quantities for sowing activities. Preference will be given to harvesting of local seed to promote the ecological benefits of local provenance seed.

- Replanting activities will occur after favourable rainfall, which is normally during spring/summer.

- On-going weed control and post-seeding monitoring will be conducted to determine if further direct drilling enhancement planting is required.

Once these areas meet the performance criteria for the Bluegrass ecological community, they will be managed in accordance with the sustainable grazing areas.

3.8. Offsets Performance Measuring and Monitoring

Performance criteria for the offset areas will be assessed as per the condition thresholds for the historical listing advice for the Bluegrass ecological community (section 3.3).

A monitoring and evaluation plan will be developed for all management areas and will be consistent with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Neldner et al., 2012) in combination with the Biocondition methodology for treeless ecosystems (DERM, 2011). Monitoring results will be evaluated against associated management objectives for each Bluegrass management area and reported to provide improved knowledge and understanding of maintaining existing Bluegrass ecological communities, and methods for sustainable grazing, assisted natural regeneration and rehabilitation (re-establishment).

The BOMP provides an opportunity to improve knowledge in natural grassland ecological restoration and management.

4. Bluegrass Offset Management Plan – Possible Additional Management Actions

The NHG's offsets were calculated based on 100% direct contribution. As a result, no indirect offsets will be required. The NHG may undertake a number of additional management actions, which are listed in Table 4-1. These additional management actions are consistent with the Bluegrass Recovery Plan (EPA, 2007, Appendix C). Broad descriptions of the proposed management actions are provided in part 5 of Appendix C. The main intention of additional management actions is to create awareness, improve knowledge and understanding of Bluegrass ecological community management, and to encourage ecological restoration.

Table 4-1 Possible Additional Management Actions - BOMP

Management Action	Short description	Possible Delivery Option
Action 1.1	Promote landholder awareness of sustainable management practices and their importance to the preservation of bluegrass grasslands' environmental and pastoral values.	Partnership with the Condamine Alliance (Local NRM Group)
Action 1.2	Encourage landholders to enter into conservation agreements over bluegrass grasslands.	BOMP
Action 2.1.1	Encourage graziers to fence bluegrass grasslands out from other land types and to subdivide bluegrass grasslands to facilitate sound grazing management, including spelling from grazing during critical periods in the summer growing season.	BOMP
Action 2.1.2	Research and develop use of bluegrass grassland species for pasture renovation and land rehabilitation, and encourage mines, main roads and others to use native species in plantings by establishing a seed bank from which seed may be purchased at competitive prices.	APC, NAC

5. Risk Management Strategy

The NHG believes the risk of failure of its Bluegrass ecological community offsets is very low based on the following facts and observations.

- The APC's Pastoral Manager is skilled in pasture management and is dedicated to supporting the establishment of the offset package on APC owned land as part of the NHG's greater business requirements.
- The APC's Pastoral Manager has demonstrated areas on APC land where the Bluegrass ecological community is regenerating naturally with the removal of intense farming pressures.
- The local Acland Bluegrass ecological community species appear to possess a reasonable degree of resilience via a good soil seed bank and an ability to proliferate during good seasons under a regime of sustainable agricultural practices.
- The offset package will be established on areas not disturbed by mining within an in-situ soil profile that appears to possess a suitable natural seed and propagule bank.
- The NHG is committed to a robust and regular monitoring regime based on identifying the status of the offset package's ecological condition and pasture establishment success. The monitoring information will be used to demonstrate and report revegetation success and guide maintenance activities.
- The APC's Pastoral Manager will provide support for maintenance activities such as seed collection and weed management.

In the event scientific evidence demonstrates the NHG's offset package is failing over time, the NHG will engage a third party offset broker to source a suitable replacement offset strategy and will implement the replacement offset strategy in an expedient manner. If required to offset, the NHG will enter into a financial assurance arrangement with the SEWPaC by legal or other agreement.

6. Conclusion

The BOMP is consistent with the requirements of the SEWPaC's EOP because it supports the delivery of a 'net gain' direct offset for the revised Project's residual impact on the endangered Bluegrass ecological community. The BOMP is based on the provision of a 100% direct offset package.

Applying the offsets calculator provided in the EOP as a guide, the BOMP should score high points as it is ready for immediate delivery on land owned by the NHG, is located adjacent to the impact site, contributes to a State significant biodiversity area, and provides a positive conservation outcome. The translocation sites for threatened species impacted upon by the revised Project will improve the ecological value of the direct offset package.

The NHG will ensure the Bluegrass ecological community offsets are appropriately monitored to demonstrate establishment success and guide maintenance requirements. The NHG will ensure the Bluegrass ecological community offsets are protected in perpetuity by a suitable legal mechanism. If required, the NHG will enter into a suitable legal or other agreement to manage any risk associated with establishing its Bluegrass ecological community offsets.

In conclusion, the BOMP offers a net gain increase in the extent and quality of the Bluegrass ecological community within the Acland area and contributes to local, State and national environmental outcomes for biodiversity through the establishment of a functional Bluegrass ecological community.

7. References

Butler, D.W. 2007. *Recovery plan for the "Bluegrass (Dichanthium spp.) dominant grasslands in the Brigalow Belt bioregions (north and south)" endangered ecological community.* Department of the Environment and Heritage, Canberra. Queensland Parks and Wildlife Service, Brisbane 2007.

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Franks, A.J. (2011). *BioCondition: A Condition Assessment Framework for Terrestrial*

Biodiversity in Queensland. Assessment Manual. Version 2.1. Department of Environment and Resource Management (DERM), Biodiversity and Ecosystem Sciences, Brisbane 2011.

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SKM 2007. *New Acland Stage 3 – Baseline Environmental Studies, Terrestrial Flora and Fauna.* Sinclair Knight Merz 2007.

SKM 2011. New Acland Coal Mine Stage 3 revised Project Natural grassland re-assessment to inform Offset Strategy Final (3). Sinclair Knight Merz, Brisbane QLD 2011.

Appendix A Natural Grassland Re-assessment

Recommendation to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on a public nomination for an ecological community listing on the *Environment Protection and Biodiversity Conservation Act 1999* (the Act)

1. Generally accepted name

Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)

2. International/National Context

Grasslands dominated by Bluegrass (*Dichanthium* spp.) occur over a broad geographic range in Queensland including the Brigalow Belt (North and South), the Desert Uplands and the Gulf Plains. However, species composition of these grasslands is strongly influenced by soil type and accordingly displays a high degree of variation across their national distribution.

The species, *Dichanthium sericeum*, also occurs in New South Wales, but current information indicates that it does not dominate any grassland communities there.

3. How judged by TSSC in relation to the *Environment Protection and Biodiversity Conservation Act 1999* criteria.

The TSSC judges the ecological community to be eligible for listing as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*. The justification against the criteria is as follows:

Criterion 1 – Decline in geographic distribution

Current estimates of the extent of the ecological community **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)** indicate that it has declined to approximately 20% (232,260 hectares) of its former extent (1,122,181 ha). These figures are based on the most recent Landsat imagery. However, it is recognised that Landsat imagery is unable to determine the condition of grassland communities, particularly the degree to which exotic pasture species and weeds have invaded natural grasslands.

It is likely that the current figure of extent significantly overestimates the area of the ecological community **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)** that exists in a semi-natural condition.

Recognising that pasture and weed species (in particular, *Parthenium hysterophorus*) are certain to occur in significant areas of the ecological community (conservatively estimated at 50%), it is appropriate that the TSSC adopt a precautionary approach for the listing of this community.

Therefore, due to the decline in geographic distribution of the ecological community to approximately 10% (116,130 ha) of its former range, **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)** is eligible for listing as **Endangered** under this criterion.

Criterion 2 – Small geographic distribution coupled with demonstrable threat

Based on the above estimate of current extent (116,130 hectares), the ecological community **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions**

(North and South) is limited, and could conservatively be considered restricted, in its geographic distribution as defined by the TSSC.

The major threat to the Bluegrass grasslands is their ongoing conversion from native pastures to cropping systems. The overgrazing of Bluegrass grasslands enables the invasion of the exotic herb *Parthenium hysterophorus*, thus lowering the value of the native grassland for grazing. The low grazing value of the grasslands then favours their conversion to a cropping system.

Therefore, the persistence of threats such as weed invasion, overgrazing and clearing for cropping and improved pasture systems combined with the restricted geographic distribution of the ecological community, **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)** is eligible for listing as **Endangered** under this criterion.

Criterion 3 – Loss or decline of functionally important species

The nominations provide no information under this criterion.

Criterion 4 – Reduction in community integrity

The nominations provide no information under this criterion.

Criterion 5 – Rate of continuing detrimental change

The nominations provide no information under this criterion.

Criterion 6 – Quantitative analysis showing probability of extinction

The nominations provide no information under this criterion.

4. Conclusion

The ecological community **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)** has experienced a severe decline in extent and is subject to such ongoing threatening processes as clearing and weed invasion. The community is therefore eligible for listing as **Endangered** under criteria 1 and 2.

5. Recommendation

The TSSC recommends that the nominations for:

- (11.8.11[1]) Dichanthium sericeum grassland + emergent trees open woodland on Cainzoic igneous rocks, in particular fresh basalt
- (11.4.4) Grassland of *Dichanthium sericeum* and or *Astrebla* species on Cainzoic alluvial clay plains

be rejected as individual nominations. The TSSC further recommends that the list referred to in section 181 of the EPBC Act be amended by including in the list in the **endangered** category the ecological community:

> **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Bioregions (North and South)**.

[1] Numbers in brackets are "regional ecosystems" as described in Sattler, P. and Williams, R. (eds), 1999, The Conservation Status of Queensland's Bioregional Ecosystems

6. Attachment (i)

The ecological community **Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Bioregions (North and South)** includes:

(11.8.11) *Dichanthium sericeum* grassland + emergent trees open woodland on Cainzoic igneous rocks, in particular fresh basalt;

(11.4.4) Grassland of *Dichanthium* spp., +/- *Astrebla* spp. on Cainozoic clay plains including weathered Tertiary basalt - Patches of low *Acacia harpophylla* in places;

(11.3.21) Grassland of *Dichanthium sericeum* and or *Astrebla* species on Cainzoic alluvial clay plains; and

(11.9.12) *Dichanthium sericeum* grassland with clumps of *Acacia harpophylla* on Cainozoic fine-grained sedimentary rocks.

Appendix B Survey sites and results

Site number: A2108 - Bio 1 Date: 21/08/13	Benchmark (11.3.21) RE/Landtype (3), Bioregion (11)		BioCondition Plot Paddock with natural grass elements			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees			no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*		
	n/a					
Tree canopy height (m)						
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*		
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a		% recruitment	n/a		
			% of benchmark	*n/a*		
Tree canopy cover (%)						
Canopy	n/a		% canopy cover	n/a		
			% of benchmark	*n/a*		
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %		% shrub cover	2.4		
			% of benchmark	*240.0*		
Coarse woody debris (m/ha)	n/a		m cwd	n/a		
			% of benchmark	*n/a*		
Native plant spp. richness		*10*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*		
Shrubs	3 spp.		no. shrub spp.	1		
			% of benchmark	*33.3*		
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	9		
			% of benchmark	*75.0*	2.5	**5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	8	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	38		
			% of benchmark	*74.5*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***50***				**13**
Adjusted Score (Grassland)						**26**
BioCondition Class						**4**

Site number: A2108 - Bio 2 Date: 21/08/13	RE/Landtype (8), Bioregion (11)		BioCondition Plot Grazed paddock dominated by Blue Grass			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	1		
			% of benchmark	*33.3*	2.5	
Grass	8 spp.		no. grass spp.	3		
			% of benchmark	*37.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	10		
			% of benchmark	*83.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	8	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	48		
			% of benchmark	*94.1*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2208 - Bio 1 Date: 22/08/13	RE/Landtype (3), Bioregion (11)		BioCondition Plot Galgai's in area are frequent + wet species present. Paddock proposed for offset.			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	0		
			% of benchmark	*0.0*	2.5	
Grass	8 spp.		no. grass spp.	3		
			% of benchmark	*37.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	7		
			% of benchmark	*58.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	3	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	21		
			% of benchmark	*41.2*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2208 - Bio 2 Date: 22/08/13	RE/Landtype (3), Bioregion (11)		BioCondition Plot Paddock on alluvial			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	1		
			% of benchmark	*33.3*	2.5	
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	5		
			% of benchmark	*41.7*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	3	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	36		
			% of benchmark	*70.6*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2208 - Bio 3			BioCondition Plot			
Date: 22/08/13	RE/Landtype (8/9), Bioregion (11)		Fairly weedy paddock with ≥ 30% blue grass cover			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	2		
			% of benchmark	*66.7*	2.5	
Grass	8 spp.		no. grass spp.	5		
			% of benchmark	*62.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	12		
			% of benchmark	*100.0*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	10	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	24		
			% of benchmark	*47.1*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2308 - Bio 3 Date: 23/08/13	RE/Landtype (3), Bioregion (11)		BioCondition Plot Paddock for potential grassland offset			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	0		
			% of benchmark	*0.0*	2.5	
Grass	8 spp.		no. grass spp.	3		
			% of benchmark	*37.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	17		
			% of benchmark	*141.7*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	8	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	0		
			% of benchmark	*0.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	8		
			% of benchmark	*19.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2208 - Bio 4			BioCondition Plot			
Date: 22/08/13	RE/Landtype (8/9), Bioregion (11)		Weedy paddock			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	2		
			% of benchmark	*66.7*	2.5	
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	18		
			% of benchmark	*150.0*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	15	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	52		
			% of benchmark	*102.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2308 - Bio 2			BioCondition Plot			
Date: 23/08/13	RE/Landtype (3), Bioregion (11)		Paddock dominated by *Eragrostis* sp. With Gilgais - offset proposed			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	0		
			% of benchmark	*0.0*	2.5	
Grass	8 spp.		no. grass spp.	2		
			% of benchmark	*25.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	12		
			% of benchmark	*100.0*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	4	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	0		
			% of benchmark	*0.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	9		
			% of benchmark	*21.4*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2308 - Bio 1 Date: 23/08/13	RE/Landtype (3), Bioregion (11)		BioCondition Plot Bluegrass dominated (80%) paddock			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	0		
			% of benchmark	*0.0*	2.5	
Grass	8 spp.		no. grass spp.	2		
			% of benchmark	*25.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	15		
			% of benchmark	*125.0*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	11	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	0		
			% of benchmark	*0.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	18		
			% of benchmark	*42.9*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A2008 - Bio 1			BioCondition Plot			
Date: 20/08/13	RE/Landtype (21/3), Bioregion (11)		Potential grassland - *Dichanthium* sp. dominant			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	0		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	1		
			% of benchmark	*33.3*	2.5	
Grass	8 spp.		no. grass spp.	5		
			% of benchmark	*62.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	13		
			% of benchmark	*108.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	9	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	51		
			% of benchmark	*100.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	0		
			% of benchmark	*0.0*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: B200813BC1 Date: 20/08/13	Benchmark (11.8.5) RE/Landtype (8), Bioregion (11)		BioCondition Plot Open *Eucalyptus orgadophila woodland* w. shrubby *Opuntia tomentosa understorey*			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	15		
Eucalypts			no. non-Euc.	0		
Non-eucalypts			% of benchmark	*n/a*	15	**15**
Tree canopy height (m)		*5*				
Canopy			canopy (m)	16		
			% of benchmark		5	**5**
Sub-canopy			sub-canopy (m)	6		
			% of benchmark			
Recruitment of canopy species (%)		*5*	% recruitment	100		
			% of benchmark		5	**5**
Tree canopy cover (%)						
Canopy		*5*	% canopy cover	18.0		
			% of benchmark		5	**5**
Sub-canopy			% subcanopy cover	0		
			% of benchmark			
Shrub cover (%)	%	*5*	% shrub cover	17.0		
			% of benchmark	*#DIV/0!*	3	**3**
Coarse woody debris (m/ha)		*5*	m cwd	15		
			% of benchmark		5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	1		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	1		
			% of benchmark	*33.3*	2.5	
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	4		
			% of benchmark	*33.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	10	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	69		
			% of benchmark	*135.3*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	28.8		
			% of benchmark	*68.6*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score (Wooded Ecosystem)						**58.5**
BioCondition Class						**3**

Site number: B210813BC1 Date: 21/08/13	Benchmark (11.9.5) RE/Landtype (9), Bioregion (11)		BioCondition Plot Dense medium-high woodland of *Casuarina cristata* with occasional stumps of former eucalypts, and sparse ground layer.			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a cm (DBH)		no. non-Euc.	0		
	n/a /hectare					
Non-eucalypts	30 cm (DBH)		% of benchmark	*0.0*	0	**0**
	98 /hectare					
Tree canopy height (m)		*5*				
Canopy	25		canopy (m)	12		
			% of benchmark	*48.0*	3	**3**
Sub-canopy	8		sub-canopy (m)	6		
			% of benchmark	*75.0*		
Recruitment of canopy species (%)	100	*5*	% recruitment	100		
			% of benchmark	*100*	5	**5**
Tree canopy cover (%)						
Canopy	59	*5*	% canopy cover	68.0		
			% of benchmark	*115.3*	2.5	**2.5**
Sub-canopy	48		% subcanopy cover	0		
			% of benchmark	*0*		
Shrub cover (%)	11 %	*5*	% shrub cover	0.0		
			% of benchmark	*0.0*	0	**0**
Coarse woody debris (m/ha)	16 m	*5*	m cwd	2		
			% of benchmark	*12.5*	2	**2**
Native plant spp. richness		*20*				
Trees	2 spp.		no. tree spp.	2		
			% of benchmark	*100.0*	5	
Shrubs	10 spp.		no. shrub spp.	6		
			% of benchmark	*60.0*	2.5	
Grass	4 spp.		no. grass spp.	4		
			% of benchmark	*100.0*	5	
Other/forbs	9 spp.		no. other/forb spp.	2		
			% of benchmark	*22.2*	0	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	1	10	**10**
Native perennial grass cover (%)	4 %	*5*	% native grass cover	46		
			% of benchmark	*1150.0*	5	**5**
Organic litter cover (%)	66 %	*5*	% organic litter cover	50.8		
			% of benchmark	*77.0*	5	**5**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**45**
Adjusted Score						**45**
BioCondition Class						**3**

Site number: A220813BC1 Date: 22/08/13	Benchmark (11.8.11) RE/Landtype (9), Bioregion (11)		BioCondition Plot Almost flat native grassland within patchy very open woodland of *Eucalyptus orgadophila* .			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees			no. Euc.	1		
Eucalypts	n/a cm (DBH) n/a /hectare		no. non-Euc.	0		
Non-eucalypts	n/a cm (DBH) n/a /hectare		% of benchmark	*n/a*		
Tree canopy height (m)						
Canopy	n/a		canopy (m)	0		
			% of benchmark	*n/a*		
Sub-canopy	n/a		sub-canopy (m)	0		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a		% recruitment	0		
			% of benchmark	*n/a*		
Tree canopy cover (%)						
Canopy	n/a		% canopy cover	4.6		
			% of benchmark	*n/a*		
Sub-canopy	n/a		% subcanopy cover	3.9		
			% of benchmark	*n/a*		
Shrub cover (%)	n/a %		% shrub cover	0.0		
			% of benchmark	*n/a*		
Coarse woody debris (m/ha)	n/a m		m cwd	4.5		
			% of benchmark	*n/a*		
Native plant spp. richness		*10*				
Trees	n/a spp.		no. tree spp.	0		
			% of benchmark	*n/a*		
Shrubs	n/a spp.		no. shrub spp.	0		
			% of benchmark	*n/a*		
Grass	11 spp.		no. grass spp.	2		
			% of benchmark	*18.2*	0	
Other/forbs	17 spp.		no. other/forb spp.	4		
			% of benchmark	*23.5*	0	**0**
Non-native plant cover (%)	0	*10*	% non-native plant cover	10	5	**5**
Native perennial grass cover (%)	43 %	*5*	% native grass cover	58		
			% of benchmark	*134.9*	5	**5**
Organic litter cover (%)	13 %	*5*	% organic litter cover	35		
			% of benchmark	*269.2*	3	**3**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***50***				**13**
Adjusted Score						**26**
BioCondition Class						**4**

Site number: A220813BC2 Date: 22/08/13	Benchmark (11.8.5) RE/Landtype (8), Bioregion (11)		BioCondition Plot Very open woodland of *Eucalyptus orgadophila* with clumped understorey of *Ehretia membranifolia* .			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	10		
Eucalypts	n/a		no. non-Euc.	2		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	16		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	10		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	50		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	14.0		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	5		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	1.0		
			% of benchmark	*100.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	44.5		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	0 spp.		no. tree spp.	2		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	4		
			% of benchmark	*133.3*	2.5	
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	11		
			% of benchmark	*91.7*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	5	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	26		
			% of benchmark	*51.0*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	59		
			% of benchmark	*140.5*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: A220813BC3 Date: 22/08/13	Benchmark (11.8.5) RE/Landtype (8), Bioregion (11)		BioCondition Plot Very open woodland to savannah of *Eucalyptus orgadophila* with grassy understorey of frequent tree pear.			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	2		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	17		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	0		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	21.0		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	6.6		
			% of benchmark	*660.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	23		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	1 spp.		no. tree spp.	1		
			% of benchmark	*100.0*	5	
Shrubs	3 spp.		no. shrub spp.	3		
			% of benchmark	*100.0*	2.5	
Grass	8 spp.		no. grass spp.	4		
			% of benchmark	*50.0*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	10		
			% of benchmark	*83.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	5	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	64		
			% of benchmark	*125.5*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	27.6		
			% of benchmark	*65.7*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Site number: 2308BC1 Date: 23/08/13	Benchmark (???) RE/Landtype (3), Bioregion (11)		BioCondition Plot			
Attribute	**Threshold**	**Weighting (%)**	**Value**		**Sub-score**	**Score**
Large trees		*15*	no. Euc.	0		
Eucalypts	n/a		no. non-Euc.	0		
	n/a					
Non-eucalypts	n/a		% of benchmark	*n/a*	15	**15**
	n/a					
Tree canopy height (m)		*5*				
Canopy	n/a		canopy (m)	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		sub-canopy (m)	n/a		
			% of benchmark	*n/a*		
Recruitment of canopy species (%)	n/a	*5*	% recruitment	n/a		
			% of benchmark	*n/a*	5	**5**
Tree canopy cover (%)						
Canopy	n/a	*5*	% canopy cover	n/a		
			% of benchmark	*n/a*	5	**5**
Sub-canopy	n/a		% subcanopy cover	n/a		
			% of benchmark	*n/a*		
Shrub cover (%)	1 %	*5*	% shrub cover	3.8		
			% of benchmark	*380.0*	3	**3**
Coarse woody debris (m/ha)	n/a	*5*	m cwd	n/a		
			% of benchmark	*n/a*	5	**5**
Native plant spp. richness		*20*				
Trees	1 spp.		no. tree spp.	0		
			% of benchmark	*0.0*	5	
Shrubs	3 spp.		no. shrub spp.	2		
			% of benchmark	*66.7*	2.5	
Grass	8 spp.		no. grass spp.	5		
			% of benchmark	*62.5*	2.5	
Other/forbs	12 spp.		no. other/forb spp.	7		
			% of benchmark	*58.3*	2.5	**12.5**
Non-native plant cover (%)	0	*10*	% non-native plant cover	7	5	**5**
Native perennial grass cover (%)	51 %	*5*	% native grass cover	33		
			% of benchmark	*64.7*	3	**3**
Organic litter cover (%)	42 %	*5*	% organic litter cover	*47*		
			% of benchmark	*111.9*	0	**0**
Landscape context (fragmented)						
Patch size		*10*				
Context		*5*				
Connectivity		*5*				
Total Score		***100***				**58.5**
Adjusted Score						**CHANGE IF GRASSLAN**
BioCondition Class						**1**

Appendix C Bluegrass Recovery Plan

Recovery plan for the "Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)" endangered ecological community.

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Recovery plan for the "Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)" endangered ecological community.

Copies may be obtained from the:
Executive Director
Conservation Services
Queensland Parks and Wildlife Service.
PO Box 15155
City East, Qld, 4002

Disclaimer:
The Australian Government, in partnership with the Environmental Protection Agency/Queensland Parks and Wildlife Service, facilitates the publication of recovery plans to detail the actions needed for the conservation of threatened native wildlife.

The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved, and may also be constrained by the need to address other conservation priorities. Approved recovery actions may be subject to modification due to changes in knowledge and changes in conservation status.

Publication reference:
Butler, D.W. 2007. Recovery plan for the "Bluegrass (*Dichanthium* spp.) dominant grasslands in the Brigalow Belt bioregions (north and south)" endangered ecological community. Report to Department of the Environment and Heritage, Canberra. Queensland Parks and Wildlife Service, Brisbane.

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Executive Summary

Community
This recovery plan is for four types of bluegrass grassland in the Brigalow Belt bioregion. These grasslands are collectively recognised as a threatened ecological community, referred to as "Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)". They represent some of the prime agricultural lands of Australia and, as such, have been highly modified under Government direction for 150 years (Weston *et al.* 1981).

Conservation status
The "Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)" is listed as an 'Endangered' ecological community under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These 'Endangered' grassland types are referred to throughout this plan as the bluegrass grassland EC. The component grassland types (regional ecosystems) included in the bluegrass grassland EC are listed under Queensland's *Vegetation Management Act (1999)* as 'Endangered', 'Of-concern' and 'Not of concern' but their tendency for degradation means they are considered 'Of-concern' or 'Endangered' in terms of biodiversity status, relevant to *Environmental Protection Act 1994* (Qld).

Habitat and distribution summary
Bluegrass dominant grasslands occur on heavy black clay soils throughout the Brigalow Belt Bioregions. Their distribution had two main centres in Queensland – the Darling Downs and the Central Highlands – and also extended into New South Wales on the eastern Barwon River plains near Moree. The Darling Downs consisted of 390,000 hectares of grassland, of which 99 percent have been transformed, mainly into grain cropping. About 70 percent of the grasslands in the Central Highlands have also been replaced. Persistent grazing has changed the composition of much remaining grassland, so that plants of relatively low palatability are often dominant, and the grazing-sensitivity of some plants has largely restricted them to roadsides and other non-agricultural locations.

Threat summary
- expansion of exotic pastures and tree crops
- expansion of mining activities
- expansion of cultivation for cropping
- persistent heavy grazing
- invasive species
- construction of roads and other infrastructure
- lack of knowledge

Recovery objectives
The overall objective of this plan is to maintain and conserve the environmental and pastoral values of the bluegrass grassland EC over the long term, by minimising the loss of such grasslands and encouraging improvement in their condition and management.

Specific objectives identified are:

S.O. 1. Maintain the remnant areas of the bluegrass grassland EC in subregions in which its extent is 30 percent or less of its pre-clearing extent and, in other subregions, maintain the remnant areas of the bluegrass grassland EC that are either known habitat for threatened species, are infrequently grazed, or are larger than 50 ha in area.

S.O. 2 Improve the condition of bluegrass grasslands across the Brigalow Belt.

S.O. 3 Maintain or enhance populations and knowledge of threatened flora and fauna from bluegrass grasslands, such as grazing sensitive plants.
S.O. 4 Improve knowledge of key ecosystem components, such as perennial grasses and legumes, and identify appropriate management practices that will contribute to S.O. 2.

Performance criteria

Progress toward the objectives of this plan can be measured against the following performance criteria:

C 1 The area of the bluegrass grassland EC in extensively developed subregions (30 percent or less of EC's pre-clearing extent remaining) does not decline, and no remnant areas 50 ha or larger, or known to support threatened species, or in infrequently grazed situations (such as on public land) are cultivated, mined or otherwise rendered non-remnant between 2007 and 2011.
C 2.1.1 Fencing and water infrastructure in grazed portions of the bluegrass EC is modified to better integrate the ecological needs of the grasslands into grazing management, principally for spelling during the growing season.
C 2.1.2 Greater frequency of palatable perennial grasses in 2011 than in surveys conducted in February-March 2005.
C 2.2 Improved condition of grasslands on stock routes, travelling stock reserves, and road and rail corridors in the Central Highlands and on the Darling Downs.
C 3.1 Monitoring established for selected populations of Belyando cobblers-peg, Dalton weed, finger panic grass, five-clawed worm skink, downs Cymbonotus, grassland earless dragon, king bluegrass, poppy-leaf nightshade, plains Picris and winged nightshade across the EC and these populations are extant in 2011.
C 3.2 Increased knowledge of the ecology threatened species, documented in peer-reviewed publications.
C 4.1 Increased knowledge of the ecology of key ecosystem components and their responses to common management practices documented in peer-reviewed publications and summarised into public information resources.

Summary of actions

The following actions are recommended:

A 1.1 Promote landholder awareness of sustainable management practices and their importance to the preservation of bluegrass grasslands' environmental and pastoral values.
A 1.2. Encourage landholders to enter into conservation agreements over bluegrass grasslands.
A 1.3 Increase the area of bluegrass grassland in the conservation estate.
A 2.1.1 Assist graziers to fence bluegrass grasslands out from other land types and to subdivide bluegrass grasslands to facilitate sound grazing management, including rest from grazing during critical periods in the summer growing season.
A 2.1.2 Research and develop use of bluegrass grassland species for pasture renovation and land rehabilitation, and encourage mines, main roads and others to use native species in plantings by establishing a seed bank from which seed may be purchased at competitive prices.
A 2.2 Monitor and work to improve the condition of priority grasslands in stock routes in the Central Highlands and Darling Downs.
A 3.1 Monitor selected populations of Belyando cobblers-peg, Dalton weed, downs Cymbonotus, finger panic grass, five-clawed worm skink, grassland earless dragon, king bluegrass, poppy-leaf nightshade, plains Picris and winged nightshade across the EC, and continue efforts to locate the Retro slider.
A 3.2 Research into the basic ecology of key threatened species.

A 4.1 Research into the basic ecology of main ecosystem components and their response to common management practices, including a cost-benefit analysis to compare recovery actions.

Evaluation and review

The plan will be reviewed at intervals no longer than five years. Implementation will be reviewed by relevant experts and should include a cost–benefit analysis to identify those actions that deliver value.

1. General information

Conservation Status

"Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (north and south)" is listed as an 'Endangered' ecological community (EC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Four of seven types of bluegrass grassland described for the Brigalow Belt bioregion (Sattler and Williams 1999) are included in the bluegrass grassland EC listing (Table 1).

Table 1 Summary of the Regional Ecosystems (mapped and described by QLD EPA) included within EPBC Act listed bluegrass grassland endangered ecological community.

Regional Ecosystem	Short description	Distribution
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils	Occurs throughout Brigalow Belt, often as relatively small black soil flats. Most of the Darling Downs grasslands belonged to this RE. About 40,000 ha of 465,000 remain.
11.4.4	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains	Mainly in northern and eastern Brigalow Belt, particularly the Belyando Downs subregion. About 27,000 ha remain of 69,000 ha.
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	Most Central Highlands grasslands are of this type, also occurs elsewhere, notably in the Northern Bowen Basin subregion. Mapping suggests 177,000 ha remain of 548,000 ha.
11.9.12	*Dichanthium sericeum* grassland with clumps of *Acacia harpophylla* on fine-grained sedimentary rocks	Minor grassland type, mainly occurs in Dawson River Downs subregion, 4 000 ha of 24,000 ha remain.

The four Regional Ecosystems that make up the bluegrass grassland EC are also listed under Queensland's *Vegetation Management Act 1999* (VMA) as 'Endangered' (11.3.21 and 11.9.12), or 'Of-concern' (11.8.11) and 'Not of concern'. However, the VMA focuses on woody plants, and "vegetation" under the VMA excludes grass. As a result the VMA does not protect most remnant bluegrass grasslands in Queensland, other than natural woody components that occur in some bluegrass grassland Regional Ecosystems (including 11.9.12 and 11.8.11). Two of the four regional ecosystems included in the bluegrass grassland EC are exempt from requirements to apply for a permit to clear native vegetation under the VMA (11.3.21 and 11.4.4). Cultivation is not controlled under the VMA unless it involves clearing woody plants.

The original listing advice for the bluegrass grassland EC suggested that it does not occur in New South Wales. However, bluegrass dominant grasslands certainly occur in the NSW section of the Brigalow Belt South bioregion and have undergone extensive agricultural development (Hunter and Earl 2002). These grasslands are analogous to Regional Ecosystems 11.3.21 and 11.4.4 and are therefore arguably part of the bluegrass grassland EC.

International Obligations

Actions in this plan are consistent with Australia's international obligations.

Affected interests

The following organisations may have management responsibilities for the bluegrass grassland EC and threats to it identified in this plan.

Natural Resource Management Regional NRM Bodies
Burdekin Dry Tropics Board
Condamine Alliance

Desert Channels Queensland Inc.
Fitzroy Basin Association
Queensland Murray Darling Committee Inc.
South West NRM Inc.

Organisations representing landholder and public interests
AgForce
Australian Conservation Foundation
National Farmers Federation
Queensland Farmers Federation
Queensland Resources Council
Queensland Conservation Council
The Wilderness Society
Wildlife Preservation Society of Queensland
WWF Australia

Local Governments (QLD)

Bauhinia Shire	Duaringa Shire	Pittsworth Shire
Belyando Shire	Emerald Shire	Rosalie Shire
Booringa Shire	Jericho Shire	Tambo Shire
Bowen Shire	Jondaryan Shire	Taroom Shire
Broadsound Shire	Millmerran Shire	Wambo Shire
Bungil Shire	Murweh Shire	Warroo Shire
Cambooya Shire	Nebo Shire	Warwick Shire
Clifton Shire	Peak Downs Shire	

Local Governments (NSW)
Moree Plains Shire

Queensland Government
Department of Natural Resources, Mines and Water
Department of Primary Industries and Fisheries
Environmental Protection Agency/Queensland Parks and Wildlife Service
Queensland Department of Main Roads
Queensland Transport

New South Wales Government
Department of Environment and Conservation
Department of Natural Resources
Department of Primary Industries
Road and Transit Authority

Consultation with Indigenous people
Pending

Benefits of this plan to other species and communities
The actions recommended in this plan will benefit threatened species for which the bluegrass grassland EC is habitat (Table 2). The list includes several reptiles, one of which may be the only known Australian reptile to have become extinct since 1788 (Retro slider, *Lerista allanae*). This species has not been seen since 1960 but grassland reptiles such as this burrowing skink can be very difficult to find.

Table 2. Plants and animals that frequently or primarily occur in the bluegrass grassland EC and are listed as threatened under Queensland or Commonwealth legislation.

Scientific name	Common name	Commonwealth status[1]	Qld status[2]	Range
Plants				
Bothriochloa biloba	lobed bluegrass	vulnerable	no longer listed[4]	Darling Downs & NSW NW slopes & plains
Cyperus clarus	grassland sedge	not listed	vulnerable	From near Emerald to northern NSW
Dichanthium queenslandicum	king bluegrass	vulnerable	vulnerable	Grazing intolerant, most frequent in BBN, very rare on Darling Downs
Digitaria porrecta	finger panic grass	endangered	rare	Emerald-Springsure, Darling Downs & NSW NW slopes & plains
Discaria pubescens	hairy anchor plant	not listed	rare	Eastern Qld & northern NSW.
Picris evae	hawkweed	vulnerable	vulnerable	Grazing intolerant, Darling Downs & NSW NW slopes & plains
Solanum papaverifolium	poppy-leaf nightshade	not listed	endangered	Darling Downs & northern NSW
Solanum stenopterum	winged nightshade	not listed	vulnerable	From Moonie to Gayndah in southern QLD.
Stemmacantha australis	Austral cornflower	vulnerable	vulnerable	Grazing intolerant, eastern Darling Downs, Callide Valley, Carnarvon Station
Thesium australe	Austral toadflax	vulnerable	vulnerable	Grazing intolerant, southeast Qld, Carnarvon Ranges, northern NSW
Trioncinia retroflexa	Belyando cobblers-peg	not listed	endangered	Grazing intolerant, Clermont to northern Darling Downs
Animals				
Anomalopus mackayi	five-clawed worm skink	vulnerable	endangered	Darling Downs & NSW NW slopes & plains
Hemiaspis damelii	grey snake	not listed	endangered	From near Rockhampton to NW NSW.
Lerista allanae	Retro slider	endangered	endangered (extinct?)	Known from Retro, Logan Downs & Clermont in the BBN, last seen 1960
Tympanocryptis pinguicolla	grassland earless dragon	endangered	endangered	Darling Downs & Canberra-Monaro area

[1] *Environment Protection and Biodiversity Conservation Act 1999*
[2] *Nature Conservation Act 1992*
[3] *Threatened Species Conservation Act 1995*
[4] *B. biloba* was formerly listed as Vulnerable by both Qld and NSW but has been de-listed

In addition to the species listed in Table 2 there are several uncommon plants that occur predominantly in the bluegrass grassland EC but are not currently listed as threatened. Such species on the Darling Downs include downs Cymbonotus (*Cymbonotus maidenii*), plains Picris (*Picris barbarorum*) and Dalton weed (*Senecio daltonii*). Several animal species in Darling Downs grasslands are of regional conservation concern. Such species include spotted black snake (*Pseudechis guttatus*), salmon-striped frog (*Limnodynastes salmoni*), common dunnart (*Sminthopsis murina*), narrow-nosed planigale (*Planigale tenuirostris*) and Australian bustard (*Ardeotis australis*) (Hobson 2002).

Social and economic impacts
The key to retention of the endangered bluegrass grasslands in the Brigalow Belt is to halt and reverse decline in their area and condition. The approach recommended is to encourage managers of significant areas of the bluegrass grassland EC to undertake activities that will not adversely impact on the bluegrass grassland EC, and facilitate improvements in grassland condition through education and support. In some situations this may impact upon plans to intensify use and may have an economic impact. The principle activities likely to be impacted are expansion of mining, and expansion of exotic pastures or crops.

Successful implementation of recovery actions that encourage improvement in the condition and sustainable utilisation of grasslands, including financial assistance and incentives, are anticipated to produce social and economic benefits as well as environmental benefits. Bluegrass grasslands are productive native pastures and their diversity and productivity are important to the long-term resilience and sustainability of pastoralism in the Brigalow Belt (Bisset 1960, Barrett and Bishop 2000). Sustainable grazing management and resulting improvements in pasture structure should reduce the cost of weed management. Some benefits are likely to be difficult to quantify but cost-benefit analysis of recovery actions should be undertaken during subsequent reviews of the plans implementation.

2. Biological information

Community description
Bluegrass grasslands can be floristically diverse communities containing many annual and perennial grass species, as well as various sedges and other herbs such as daisies and twining legumes. The relative dominance of bluegrass can vary considerably with soil type, seasonal conditions and management. The key terms in the title “Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt bioregions (north and south)” can be explained as follows:

- **bluegrass** is a common name for grasses of the genus *Dichanthium* and *Bothriochloa*, which are typically perennial tussocks with predominantly summer growing seasons. The most prominent bluegrass in the listed community is Queensland bluegrass (*Dichanthium sericeum*). King bluegrass (*Dichanthium queenslandicum*) can also be a common grass in northern parts of the bluegrass grassland EC and is listed as Vulnerable under Queensland’s *Nature Conservation Act 1992* and the EPBC Act. King bluegrass is extremely rare on the Darling Downs however it can be common in well-managed grasslands in the Central Highlands.
- the **Brigalow Belt bioregions** (north and south) cover approximately six million hectares of predominantly sub-coastal country from Dubbo in central New South Wales to Townsville in north Queensland (Thackway and Creswell 1995).
- **grassland** is vegetation in which the predominant stratum (the vegetation layer that contains more biomass than any other layer) is typically and primarily composed of grasses. Fensham (2003) defined grasslands as “vegetation where trees and shrubs are sparse and where grasses, mostly perennial, are dominant”. Natural grasslands are widespread in Australia, particularly in arid and semi-arid areas.

Queensland bluegrass (*Dichanthium sericeum*) is a very widespread and variable summer-growing grass prominent in Australian sub-humid tussock grasslands. In eastern Australia, early botanists and pastoralists called these grasslands “bluegrass downs” to distinguish them from the semi-arid “Mitchell grass downs”. These grassland types share a broad diffuse boundary (known as an ecotone), running from west of

Clermont in central Queensland to Moree in northern NSW. Along this ecotone, a run of wet years increases dominance by bluegrass, while drier years increase the prominence of Mitchell grasses. These shifts highlight the dynamic nature of grassland species composition (Blake 1938).

Bluegrass grasslands are generally dominated by several perennial tussock grasses including Queensland bluegrass (*Dichanthium sericeum*), white speargrass (*Aristida leptopoda*), Yabilla grass (*Panicum queenslandicum*), native millet (*Panicum decompositum*), satintop (*Bothriochloa erianthoides*), coolibah grass (*Thellungia advena*), hoop Mitchell grass (*Astrebla elymoides*) and curly Mitchell grass (*Astrebla lappacea*). Annuals grasses such as Flinders grass (*Iseilema* spp) can be very prominent when grasslands are recovering from prolonged heavy grazing or other disturbances such as drought. Growing among and between the grasses are legumes (e.g. creeping tick trefoil (*Desmodium campylocaulon*), native sensitive plant (*Neptunia gracilis*) and *Vigna* spp.) as well as prostrate herbs (e.g. scurvy grass (*Commelina ensifolia*)), robust forbs (e.g. *Amaranthus* spp, bladder ketmia (*Hibiscus trionum*), *Sida* spp. and *Verbena* spp.), saltbushes (e.g. *Atriplex* spp.) and daisies (e.g. woolly fuzzweed (*Camptacra barbata*), bears-ears (*Cymbonotus* spp.), hawkweeds (*Picris* spp.), and fuzzweeds (*Vittadinia* spp.)). The diversity of life forms and species can be quite impressive. It is common to find more than 30 native plant species in 500m^2. Species composition varies with latitude; grasslands in the southern Brigalow Belt typically have more 'temperate' plants including wallaby grasses (*Austrodanthonia* spp.) and spear grasses (*Stipa* spp.) as well as more winter growing forbs (Fensham 1999).

The distribution of bluegrass grasslands within the Brigalow Belt is strongly constrained by soil type. Bluegrass grasslands occur on heavy clay soils that can range from grey to black in colour but are generally referred to as "black soils" (Blake 1938). Black soils can develop in situ on fine-grained parent rocks with low silica content, such as mudstone, shale or basalt. Alluvial deposits commonly support heavy clay soils, and black soils are especially common on alluvium in catchments composed of fine-grained, low silica rocks (McKenzie *et al.* 2004). The bluegrass grasslands of the Darling Downs occurred on basalt-derived alluvium associated with the Condamine River.

The specific factors that restrict tree growth sufficiently to produce grasslands are not well understood. Association of grasslands with heavy soils in the Brigalow Belt might be due to the way black soils swell and shrink as they wet and dry, perhaps killing young trees by breaking their root systems. Other factors such as fire, frost, extreme drying during drought and soil chemistry (particularly low sodicity) may also be important for tree exclusion (Fensham 2003).

Deep cracking on black soils is thought to be a key habitat characteristic for some of the more grassland dependent fauna, particularly reptiles such as five-clawed worm-skink (*Anomalopus mackayi*), grassland earless dragon (*Tympanocryptis pinguicolla*) and numerous other lizards and snakes (Hobson 2002). Deep soil cracks in bluegrass grasslands are also believed to be habitat for small mammals such as narrow-nosed planigale, long tailed planigale (*Planigale ingrami*), pale field rat (*Rattus tunneyi*) and common planigale (*Planigale maculata*) (Goodland 2003, Hobson 2002, Keith and Betts 2003).

Other fauna, including several grassland birds, are thought to be more dependent upon structural complexity in grassland vegetation than soil structure for habitat quality. Well-developed grass tussocks and inter-tussock spaces of varying size and character, as well as forbs, twining herbs, and decaying vegetation provide structural complexity in grasslands. Vegetation cover provides nesting material and protection from avian

predators for granivorous birds like brown quail (*Coturnix ypsilophora*), stubble quail (*Coturnix pectoralis*), little button-quail (*Turnix velox*) and red-chested button-quail (*Turnix pyrrhothorax*) as well as insectivores like rufous songlarks (*Cincloramphus mathewsi*), brown songlarks (*Cincloramphus cruralis*) and golden-headed cisticola (*Cisticola exilis*) (Goodland 2003, Hobson 2002, Keith and Betts 2003).

Bluegrass grasslands also support an array of raptors (at least 12 species) including widespread species such as brown falcons (*Falco berigora*) as well as more grassland dependant species such as spotted harrier (*Circus assimilis*) (Augusteyn and Melzer 2002, Hobson 2002).

Ecology

Substantial changes in the condition and composition of bluegrass grasslands can occur over fairly short periods. High grazing pressure can remove vegetation cover from grasslands rapidly, whereas a good season can (but won't always) induce rapid recovery of grassland from a state of low vegetation cover. However the actual composition of a given bluegrass grassland at the end of a growing season can be affected by many factors.

Rainfall (season and quantity), grazing, fire, locusts, army-worms, weed invasion and soil seed banks can significantly affect grassland condition. Of these, grazing by domestic stock is the most widespread and manageable in remnant bluegrass grasslands. Grazing by undomesticated native and feral animals can also exert significant grazing pressure. Sustained heavy grazing pressure is clearly likely to alter grassland composition but lower grazing pressure can also produce changes (Prober and Thiele 1995, Orr and Phelps 2003). Grazing animals tend to preferentially consume the soft and sweet plant parts and species within a pasture. As a result grazing tends to favour the persistence of unpalatable species over palatable species. Grazing intensity often affects species composition and relative dominance more than it affects total species richness in grasslands (McIntyre and Lavorel 1994, Fensham 1998, Fensham *et al*. 1999, Lewis 2006).

Research into grazing dynamics highlights the complexity of the interactions involved and suggests that accurately predicting the response of many species to a given grazing regime, or changes therein, is often beyond current scientific capacity. This is probably because factors such as rainfall, temperature, other disturbances, and the presence or absence of other species can all be important in determining the response of a given species to grazing. For example, 41 percent of 324 species that showed significant positive or negative responses to grazing in two or more of 55 Australian grazing studies reviewed by Vesk and Westoby (2001), showed the opposite response in at least one other study.

Grazing is not incompatible with environmental values in remnant grasslands provided grazing is managed to maintain palatable perennial grasses and legumes, and to prevent erosion. Grazing can be compatible with the survival of some grazing sensitive plants such as Belyando cobblers-peg, particularly if it occurs outside their growing season (which means winter grazing for Belyando cobblers-peg, Fensham *et al.* 2002). Moderate levels of grazing can produce the highest levels of plant species richness (Fensham 1998, Orr and Phelps 2003). Total exclusion of grazing can also have detrimental outcomes including changes in grassland structure (Orr and Phelps 2003). Low intensity or intermittent grazing can increase the availability of suitable sites for seed germination (by reducing plant cover), while high frequency grazing reduces the persistence of perennials in some grasslands (Dorrough *et al.* 2004). However, Lewis (2006) found there was little evidence that grazing is necessary to maintain species richness in bluegrass/Mitchell grass grasslands in northern New South Wales. As a general rule extreme grazing frequency and intensity decreases the dominance of

perennial plants and increases the prominence of annual grasses and herbs (Tremont 1994, Fensham *et al.*1999, Dorrough *et al.* 2004).

Pasture degradation associated with grazing in the bluegrass grasslands of Queensland's Central Highlands attracted attention soon after settlement (Bisset 1960). Substantial compositional changes had reportedly occurred prior to 1915 as a result of both extreme climatic events and grazing. The degradation was mainly increasing dominance of comparatively unpalatable native perennial tussock grasses, most frequently white spear grass (*Aristida leptopoda*) and Yabila grass (*Panicum queenslandicum*) (Everist 1939). Signs of more severe degradation in bluegrass/Mitchell grass grasslands include dominance by annual grasses or forbs, or dominance by herbaceous or woody weeds (McArthur *et al.* 1994).

Tothill and Gillies (1992) estimated that in 1991, 60 percent of bluegrass pastures in the Central Highlands were in 'Poor' condition and 'required rehabilitation and stabilisation needing major works or landuse change'. The condition of grasslands in the southern bluegrass grasslands was apparently better than in more northern areas in 1991, with an estimated 50 percent in 'Good' condition in the south compared to 10 percent in the northern bluegrass pastures (Tothill and Gillies 1992). Parthenium (*Parthenium hysterophorus*) invasion was listed as a major factor in the poor condition of northern bluegrass pastures.

Parthenium is an annual herb from the Americas, and is a declared pest plant (class 2) in Queensland. Persistent heavy grazing and other forms of disturbance such as inappropriate fires (resulting in slow recovery) and mechanical disturbance can facilitate parthenium invasion by increasing the space available to the invasive species. Reduction in pasture cover associated with parthenium invasion can also make cultivation a more attractive proposition to landholders, increasing the weed's threat to the bluegrass EC (Fensham 1999). However, sustainable grazing management can provide effective parthenium management in many cases (Chamberlain and Gittens 2004).

Maintaining a good component of perennial grasses is the most reliable method of managing the risk of parthenium invasion and should also maximise resistance to other weed species. Strategic rest (spelling) of grassland from grazing is an essential part of best practice management of parthenium infested pastures (Chamberlain and Gittens 2004). Spelling pastures for at least six to eight weeks early in the growing season, following rain or fire, is strongly recommended to allow grassland plants to set seed, establish seedlings and replenish plant reserves.

The apparent grazing sensitivity of threatened grassland flora means that infrequently grazed grasslands such as occur in stock routes, travelling stock reserves and railway corridors are now essential habitat for several threatened plants including King bluegrass (*Dichanthium queenslandicum*), hawkweed (*Picris evae*), Austral cornflower (*Stemmacantha australis*), Austral toadflax (*Thesium australe*) and Belyando cobblers-peg (*Trioncinia retroflexa*) (Fensham 1998). Corresponding evidence for strong sensitivity to grazing has not been provided for grassland fauna, however studies are limited to date (Augusteyn and Melzer 2003). Grassland fauna are potentially threatened by grazing if it causes soil compaction or removes ground cover (Hobson 2002). Some grassland specialist fauna such as the pale field rat (*Rattus tunneyi*) and several bird species (stubble quail, brown quail, little button quail, red-chested button quail and singing bushlark) prefer habitats with high levels of vegetation cover and complexity, and are therefore likely to be threatened by management that reduces grass height and density such as persistent heavy grazing or persistent slashing.

The effect of grazing on bluegrass grasslands varies with conditions. For example, many plants are likely to be most palatable and most grazing sensitive as seedlings, which means that spelling grassland from grazing when seedlings are prevalent after rain can potentially increase recruitment of new plants. Consistent failure to spell grasslands following rain can result in deteriorating in pasture condition, including dominance by relatively unpalatable species. Summer is the most important period for successful germination and establishment of warm season perennial grasses, including bluegrass species (Lodge 1981), which suggests that spelling grasslands is particularly important following summer rainfall.

Spelling bluegrass grasslands during the summer growing season also increases the chances for plants to successfully set seed. Seed fall for many perennial grasses often begins about a month after flowering commences. Many bluegrass grassland species possess some form of seed dormancy mechanism. Such mechanisms rarely completely preclude germination immediately after seed fall but act to spread germination over a longer period (Lodge 1981, Lodge and Whalley 1981). Once pasture is dominated by relatively unpalatable species, re-establishing desirable perennial grasses can be a slow process (Bishop *et al.* 1999) and even relatively low grazing pressure appears to significantly retard recovery.

Further information on grazing management and monitoring is available from many sources including the Department of Primary Industries in New South Wales and DPI&F in Queensland.

Recovery following severe disturbance.

Severe disturbances such as cultivation presumably increase the importance of the soil seed bank to grassland recovery. The seeds of Queensland bluegrass and many other native species increase in viability for the first year after seed set and remain viable in good, dry storage for up to eight to 10 years (Silcock *et al.* 1990). However persistence in dry storage is very different to field conditions. A recent assessment of seed banks in bluegrass grassland soils stored for 10 years indicated very little germinable seed remained after this period (Butler unpublished data[1]). Seed banks in bluegrass grasslands can contain relatively low seed densities (Bahnisch *et al.* 1999). These observations suggest that soil seed banks will be valuable for recovery of severely disturbed grasslands for limited periods, estimated maximum of 4 to 5 years, beyond which seed will have to disperse into the system to effect recolonisation. Drought or grazing can reduce seed production and therefore retard recovery (Lambert *et al.* 1999).

Queensland bluegrass appears to produce seeds with high viability (100% reported by Read and Bellairs 1999, 84% reported by Silcock *et al.* 1990, and 86-92% viability reported by Lodge and Whalley 1981). Smoke has been shown to increase germination of Queensland bluegrass and greatly increases germination of native millet (*Panicum decompositum*) (Read and Bellairs 1999).

Anecdotal evidence suggests that Queensland bluegrass is a very effective coloniser of previously cultivated areas, and that the bluegrass component of bluegrass grasslands can re-establish within a few years of the cessation of cultivation (A. Goodland, J. Chamberlain, M. Olsen pers comm.). This was confirmed by observations of well-developed sward of bluegrass (including king bluegrass) in areas that had been cultivated up until 5 years earlier, in Albinia Downs National Park. This situation is exceptional because of the absence of domestic stock grazing during the recovery of the previously cultivated area.

[1] soil samples collected from bluegrass grasslands on the Darling Downs and Central Highlands in 1994 and 1995 were spread over trays of potting mix then regularly watered and monitored for 90 days. Half of the trays were also treated with smoke to test for possible germination enhancing effects. Germination of native grassland species was negligible.

More detailed survey work has demonstrated that the species richness of previously cultivated grasslands approaches that of adjacent remnant bluegrass grassland rapidly over the first 10 years, after which the rate of increase in species richness slows (Figure 1). This survey sampled 54 pairs of sites in fallow and adjacent remnant bluegrass grasslands across the Central Highlands, most of which included some grazing pressure from domestic stock. Areas that were cultivated tend to have 80 percent of the native species richness of adjacent remnant bluegrass grasslands after about 15 years of recovery. Although this study is a one-off assessment it sits well with anecdotal evidence and similar quantitative assessments from bluegrass/Mitchell grass grasslands in northern New South Wales (Lewis 2006)

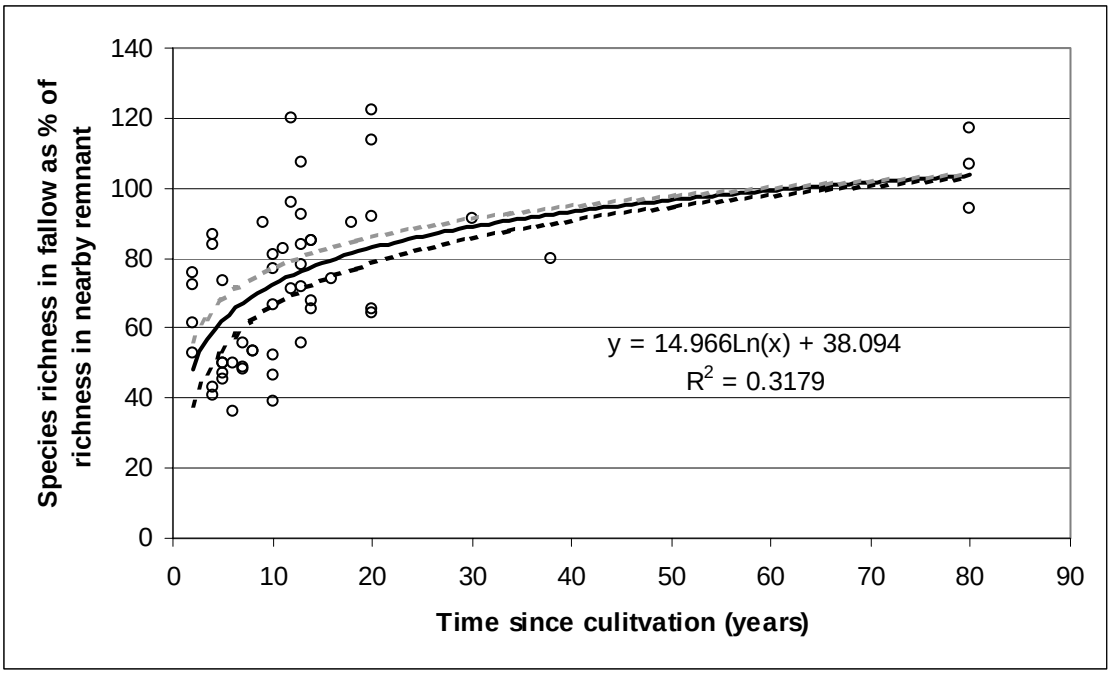


Figure 1. Association between time since last cultivation and the number of native species in previously cultivated areas as a percentage of the number of native species in adjacent remnant areas, for bluegrass grasslands in Queensland's Central Highlands.

While the overall richness of fallow paddocks increases over time, their floristic composition also changes considerably. During the first year or two they tend to support many prostrate herbs such as caltrop (*Tribulus* spp.) and cow vine (*Ipomoea lonchophylla*) and stoloniferous grasses such as *Moorochloa eruciformis*. Perennial tussock grasses establish more slowly and their establishment appears to be particularly sensitive to competition from other plants (including weeds like Parthenium) and grazing pressure. Complete "recovery" from cultivation may take considerably longer than 10 or 15 years (particularly for some long lived species such as Mitchell grasses). Grazing management and the weather can have obvious effects. For example, constant or heavy grazing appears to impede perennial grass establishment and to bias the perennial grass tussocks toward species with relatively low palatability such as white speargrass (*Aristida leptopoda*).

Distribution

Mapping of the current and historical distribution of the bluegrass grassland EC in Queensland is presented in Figure 2, similar mapping is not yet available for New South Wales. The Queensland distribution features two major areas of occurrence for the bluegrass grassland EC: the Darling Downs in the south and the Central Highlands in the north. Grasslands in these two areas differ in species composition, the Darling

Downs grasslands supporting more species typical of temperate grassy ecosystems (Fensham 1999). A third centre occurred in northern NSW, on the eastern Barwon River plains near Moree.

The total area of the four listed regional ecosystems comprising the EC within the Queensland portions of the IBRA Brigalow Belt bioregions[2] was 1,106,942 hectares prior to the commencement of cultivation. Twenty-three percent of this area (250,424 hectares) was mapped as remnant in 2003 (Queensland Herbarium Regional Ecosystem mapping, Version 5.0, released December 2005). Grasslands are classified as remnant in this mapping unless they have been cultivated within the last 15 years or are so degraded that they are unlikely to recover to a natural state in 15 years (Neldner *et al.* 2005). In practice, bluegrass grasslands that have not been cultivated in the preceding 15 years should be considered remnant as long as exotic perennial grasses contribute less than 50 percent of the total cover of perennial grasses. This rule of thumb was chosen because exotic perennial grasses are believed to be a key factor in recoverability to a 'natural state', and because it is also consistent with the 50 percent 'undisturbed' canopy cover cut-off used to distinguish remnant and non-remnant vegetation for tree and shrub dominated Regional Ecosystems. The mapped extent of remnant bluegrass grasslands is probably an over-estimate of the area of grassland fitting the remnant criteria outlined above. Although cultivation for cropping is quite apparent on satellite imagery, exotic grass establishment can be difficult to recognise. Further work on the condition of remnant grasslands will be valuable. As the apparent condition of bluegrass grasslands is highly variable, it might be more useful to assess whether grasslands that satisfy the remnant criteria generally retain the potential to attain good ecological condition over a reasonable time frame (less than 5 years) under appropriate management and median rainfall.

Twenty-five of the Brigalow Belt's 34 Queensland subregions supported the bluegrass EC prior to clearing, and two of these subregions no longer contained mapped remnant areas of the bluegrass EC in 2003 (Appendix 1, Callide Creek Downs and Taroom Downs subregions). Clearing has been most comprehensive on the Darling Downs (the Eastern Darling Downs subregion in Appendix 1). The Darling Downs originally supported more than one third of the extent of the bluegrass EC but only 1 percent of this remained in 2003. Areas of remnant grassland on the Darling Downs are of the greatest significance to the overall distribution of the bluegrass grassland EC.

The Basalt Downs subregion (the core of the Central Highlands), which includes basalt country around Clermont and Springsure (Appendix 2), now contains more of the bluegrass grassland EC than any other subregion. Three other subregions supported more than 15,000 ha of mapped remnant bluegrass grassland EC in 2003, the Claudie River Downs (southwest of Springsure), Belyando Downs (north-west of Clermont) and Northern Bowen Basin (north-east of Clermont) subregions. These three subregions together with the Basalt Downs subregion make up the Central Highlands. Recent 'clearing' of remnant grasslands (cultivation, mining, pasture development etc.) has also been concentrated in the Central Highlands, particularly in the Basalt Downs subregion (7187 ha between 1997 and 2003) and the Claudie River Downs subregion (1220 ha).

The bluegrass grassland EC in New South Wales occurs in the Moree Plains Shire and falls within the catchment of the Border Rivers and Gwydir Natural Resource Management Body. The Queensland distribution of mapped remnants of the bluegrass grassland EC includes 25 local government areas (Appendix 3) and is covered by six of Queensland's Natural Resource Management Regional NRM Bodies (Appendix 4,

[2]This excludes outlying occurrences of the listed Regional Ecosystems in adjacent bioregions, and also excludes the northern sections of the IBRA Darling Riverine Plain bioregion which project into southern Queensland but are generally treated as part of the Brigalow Belt by biodiversity planners in Queensland.

Appendix 5). The Fitzroy Basin Association's region supports 70 percent of mapped remnants, but the Burdekin Dry Tropics Board's region also supports 60 000 hectares. Sixty-two percent of mapped remnant areas of the EC occur on freehold land and 35 percent on leasehold land. Bauhinia, Belyando, Peak Downs and Emerald shires all contain substantial areas of the bluegrass grassland EC. Keith (2002) surveyed bluegrass grassland remnants on public lands in these shires and found that each support several hundred hectares of grassland with conservation value on public land, mainly on road reserves.

Overall the bluegrass grassland EC is extremely poorly represented within the conservation estate. Two percent of the remnant area of the bluegrass grassland EC occurs within conservation reserves or state forests, and of this 80 percent is in the recently acquired Albinia Downs National Park (Appendix 6, mainly RE 11.8.11). Some significant bluegrass grasslands are conserved on private nature reserves, including the Australian Bush Heritage Fund's Carnarvon Station and Goonderoo Station. Regional Ecosystems 11.4.4 and 11.9.12 are completely unrepresented in state forests or conservation reserves. It is strongly recommended that the representation of bluegrass grassland within the conservation estate be increased.

The modern distribution of the bluegrass grassland EC is substantially more fragmented than its historical distribution, indicated by greatly increased numbers of small grasslands in the landscape (Appendix 7) and reduced proportions of grassland area in large patches (Appendix 8). This change has been more pronounced in the Brigalow Belt South than in the Brigalow Belt North. In the historical distribution, about 70 percent of the extent of the bluegrass grassland EC occurred in the 5 percent of patches more extensive than 1000ha. There are few patches of this size left in the Brigalow Belt South bioregion and they only occur in the Claudie River Downs subregion, which lies in the far north of the Brigalow Belt South bioregion and is appropriately considered part of the Central Highlands grassland complex. The largest remnant patch mapped on the Darling Downs covers less than 500 ha whereas the largest patch in pre-clearing is estimated to have covered more than 230,000 ha.

Reduction in grassland extent threatens species persistence in the landscape. As for most ecosystems, very few of bluegrass grasslands' component species are reliably present in most locations. The majority of species are quite infrequent in the bluegrass grasslands. For example, 161 native vascular plants were recorded in a recent one-off survey[3] of forty-nine 10m x 50m plots in remnant bluegrass grassland in the Central Highlands. Eighteen species (11%) were recorded in more than half of the plots, no species was recorded in all plots; closest were Queensland bluegrass and rhynchosia (*Rhynchosia minima*), recorded in 48 of the 49 plots. Even if the 75 species (47 percent) that were recorded in one or two sites are excluded (as blow-ins or mis-identifications), half the remaining species were recorded in less than a quarter of plots. This suggests that rarity is a common condition for native plants (not always due to management), and also suggests that removal of large areas of habitat can impact substantially on the abundance of some species.

[3] conducted in February and March 2005

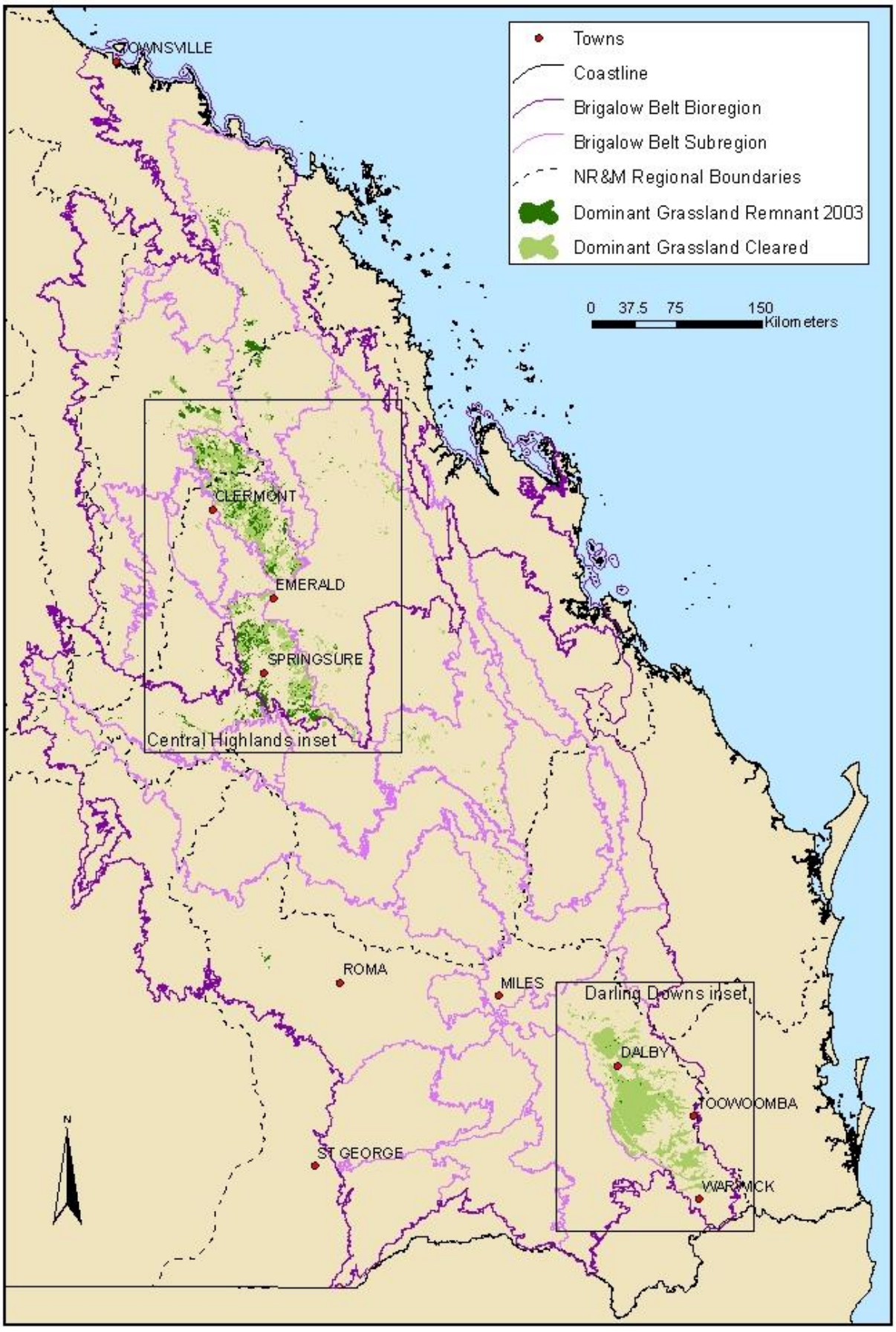
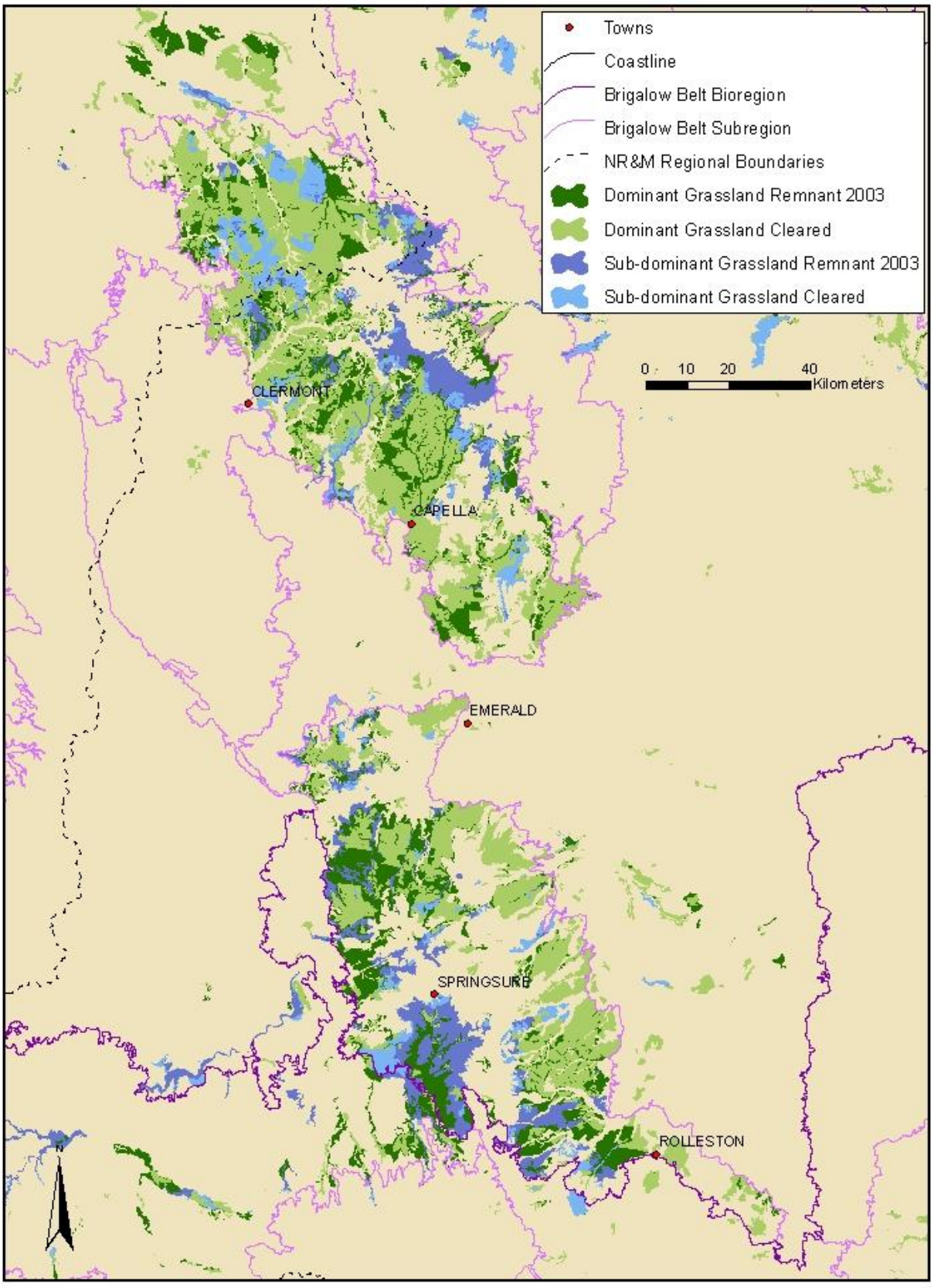
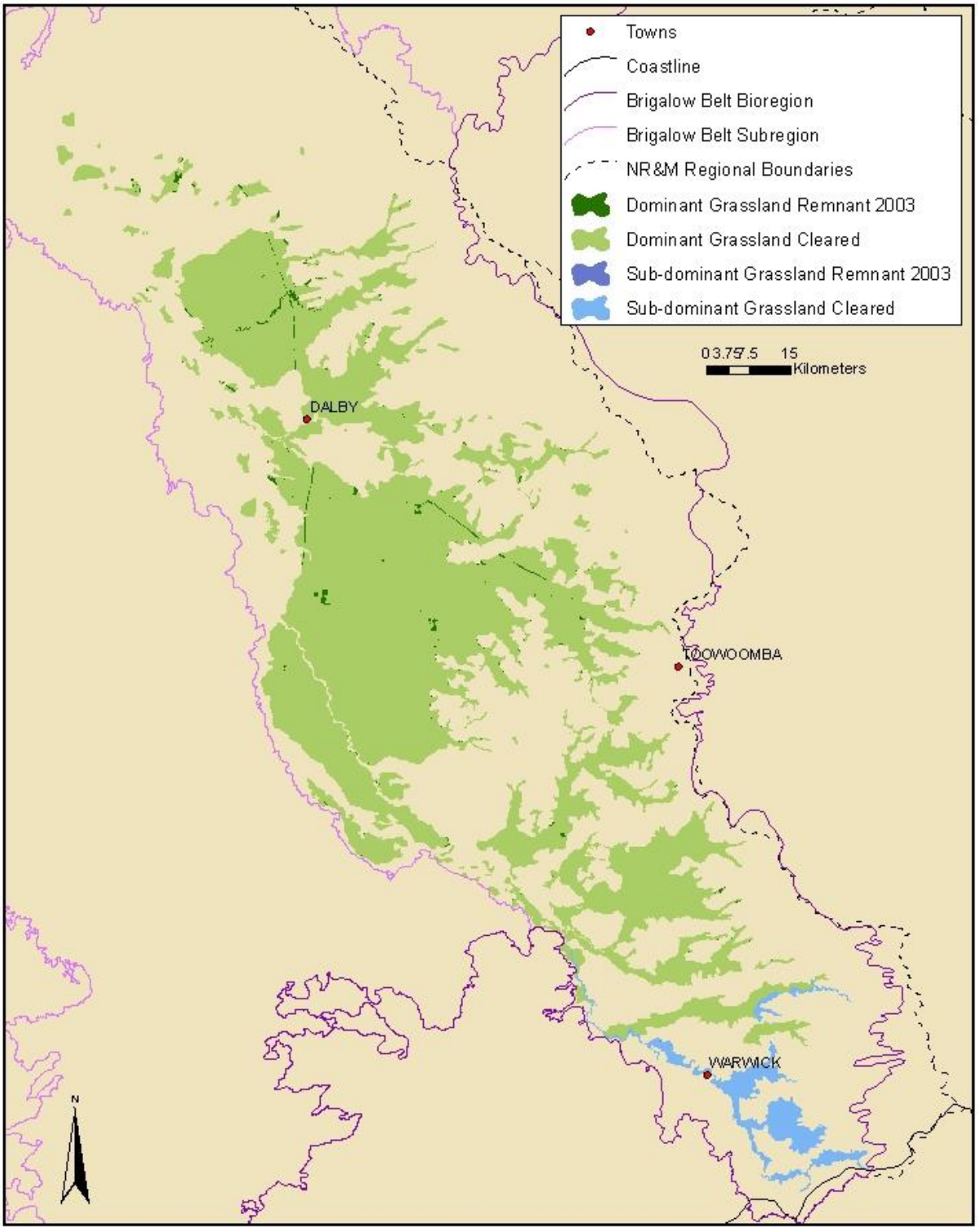


Figure 2 Distribution of bluegrass grasslands included in EPBC listing. Data from Queensland Herbarium 2005, only polygons in which EEC is dominant vegetation are shown.



Central Highlands Inset Distribution of bluegrass grasslands included in EPBC listing.
Data from Queensland Herbarium 2005.



Darling Downs Inset Distribution of bluegrass grasslands included in EPBC listing.
Data from Queensland Herbarium 2005.

Habitat critical to the survival of the community

Habitat critical to the bluegrass grassland EC includes all remnant areas of Regional Ecosystems 11.3.21, 11.4.4, 11.8.11 and 11.9.12 (or their analogues in New South Wales) within the Brigalow Belt bioregions. That is, areas which have not been cultivated within the last fifteen years and in which no more than half of the total perennial grass cover present is from exotic species. Beyond this statement, which identifies all vegetation included in the ecological community as currently mapped, higher priority areas are any that meet one or more of the following four criteria:

1. extensively developed subregion - severe reduction in grassland area on the Darling Downs means that all remaining grassland areas on the Darling Downs are habitat critical to the survival of the ecosystem and the geographic variation therein. Remaining patches in other extensively developed subregions such as the Dawson River Downs are essential habitat for the same reason. A cut-off for 30 percent of pre-clearing area remaining can be used to identify extensively developed subregions (Appendix 1), within which any remnant grassland is considered habitat critical to survival of the bluegrass grassland EC.
2. infrequent grazing - grasslands which receive infrequent grazing such as stock routes, travelling stock reserves, road and rail reserves and some paddocks (eg. weaner paddocks which are not grazed in summer) are of the highest conservation value because of the known sensitivity of many threatened grassland species to grazing.
3. threatened species – grasslands that are known habitat for any of the threatened grassland flora and fauna (listed in Table 2) are of the highest priority.
4. large area – large grassland areas are particularly valuable because large areas generally support more species and small grasslands are often over-grazed (in mixed-country paddocks). A suggested cut-off for “large” grasslands is 50 ha. (about 30 percent of BBN grassland patches in mapping, accounting for about 90 percent of BBN grassland area). Note that smaller grasslands can also be of high value for one of the three reasons listed above.

These criteria suggest that all remnant areas of the bluegrass grassland EC in subregions with less than 30 percent of their pre-clearing grassland area remaining should be considered critical habitat. Similarly, infrequently grazed areas on designated stock routes, travelling stock reserves, or on road or rail reserves are also habitat critical to the bluegrass EC, as are areas that support threatened species. Frequently grazed grasslands without threatened species that are in a subregion with more than 30 percent of the pre-clearing extent remaining, are habitat critical to the survival of the bluegrass grassland EC where they form part of a grassland covering 50 ha or more (ignoring small breaks such as roads and fencelines).

This approach avoids problematic condition thresholds for inclusion within the bluegrass grassland EC, other than the basic criteria to establish remnant status ie. at least 15 years since cultivation and less than 50% of the cover of perennial grasses provided by introduced species. Most of the criteria are based upon readily available spatial data (e.g. Regional Ecosystem Mapping, Stock Route maps), which is actively maintained and will be corrected where errors are identified. The exception is the criteria dealing with the presence of threatened species, however pre-existing data such as museum and herbarium databases can also be used as a first cut for this criterion.

3. Threats

Identification of threats

The main threats to the bluegrass EC are:

1. expansion of exotic pastures and tree crops

2. expansion of mining activities
3. expansion of cultivation for cropping
4. persistent heavy grazing
5. invasive species
6. construction of roads and other infrastructure
7. lack of knowledge

The order in which the threats are listed above is based on judgement about the area potentially affected and the severity of impact of each of the threats, it is intended to be indicative only. Each of the listed threats interact so that exposure to one will often increase the chances of others occurring. For example, degradation of remnant bluegrass grasslands by persistent heavy grazing, and associated increases in unpalatable species and invasion of weeds such as parthenium, increases the economic attractiveness of cultivation to overcome weed problems, perhaps accompanied by exotic pasture development.

1. Expansion of exotic pastures and tree crops replaces the native flora of bluegrass grasslands with cultivated species or alters the grassland structure by introducing a woody over-storey. Common cultivated pasture plants utilised in recent times have included purple pigeon grass (*Setaria incrassata*), butterfly pea (*Clitoria ternatea*), bambatsi panic (*Panicum coloratum*), Rhodes grass (*Chloris gayana* mostly variety "Callide"), buffel grass (*Cenchrus ciliaris* mainly variety "Biloela"), creeping bluegrass (*Bothriochloa insculpta,* mostly variety "Bissets"), Indian bluegrass (*Bothriochloa pertusa*), and the only common tree crop is the fodder tree Leucaena (*Leucaena leucocephala*). Some seed companies have begun offering "black soil mixes" which include selections of the grasses listed above as well as other legumes. For preservation of the natural values of bluegrass grasslands the use of native grasses and legumes for restoration of bluegrass grasslands would be preferable to exotic pastures. It is likely that some landholders would use native seeds (particularly of bluegrasses and Mitchell grasses) if they were more readily available, preferably at competitive prices.

Pasture development can involve various techniques from simply broadcasting seed (eg. some legumes), delivering seeds into fairly intact grassland soil using machinery such as "crocodile" or band seeders, through to intensive seed bed preparation by cultivation and planting. The more intensive the seedbed preparation the more native biota will be impacted. Only intensive seedbed preparation involving "ploughing" should be considered to be cultivation in terms of the remnant definition for grasslands (ie. not cultivated within last 15 years). Less intense forms of pasture development render grasslands non-remnant only if they make the grasslands native condition "unrecoverable" within the medium term, this would probably be the case if exotic perennial grasses become dominant. Some of the pasture species mentioned above can also threaten "intact" grasslands by invasion, the most notable example in recent years is the successful recent establishment of buffel grass, often in places that landholders have been broadcasting the seed for years with limited success. Whether this reflects a change in the grass or environmental change, such as recent run of dry years, remains to be seen. Such mechanically subtle forms of pasture development are difficult to detect using satellite imagery or aerial photography, which means that the mapped remnant area of the bluegrass grassland EC is an over-estimate of the actual area remaining.

Areas subject to pasture development can maintain some habitat value for bluegrass grassland flora and fauna, more so than areas subject to regular cultivation for cropping. For example, although development of butterfly pea pastures generally involves intense seedbed preparation, the fairly open pastures produced by butterfly pea often also feature native annual grasses such as Flinders grass (*Iseilema* spp.), as

well as colonising vines such as caltrop (*Tribulus* spp.) and cow vine (*Ipomea lonchophylla*). Conversion of grasslands into leucaena (*Leucaena leucocephala*) plantations can sometimes briefly improve the condition uncultivated areas of bluegrass grassland in the same paddock, because grazing must be tightly controlled while the leucaena is establishing. However over the longer term, unless leucaena is planted in very wide rows (eg. 20 m spacing), establishment of leucaena will substantially alter the grassland between the rows, and areas planted to dense leucaena will not be recognised as remnant grassland.

2. Expansion of mining activities threatens the bluegrass grassland EC because it can result in the physical destruction of grasslands. The Brigalow Belt in Queensland is a centre for coal production, and mining activity, including exploration, in the Central Highlands is expanding. Long wall mining has the potential to affect substantial areas of the bluegrass grassland EC. Construction of other infrastructure associated with mining activities such as roads, conveyors and spoil heaps can also be important factors in the overall impact of expanding mining activities.

The high value of the resource developed by mining means that mines are well placed to mitigate against impacts their activities have on remnant grasslands by rehabilitating greater areas of degraded but otherwise comparable habitat. Care should be taken when evaluating such arrangements to ensure that the promised offset is delivered prior to the destruction of the pre-existing high-value habitat. If mine sites include grasslands that are out of the mine's direct path, mining companies are well placed to manage such grasslands for environmental benefit and should be encouraged to do so. Nature refuge agreements or similar arrangements may be useful in such instances.

3. Expansion of cultivation for cropping remains an ongoing and immediate threat to the extent of bluegrass grasslands. Conversion of grassland to cropping removes many of the environmental values of the grassland, although cultivation paddocks may have residual value for some fauna and ruderal plants. A range of very valuable grain, pulse and forage crops are grown on the black vertosols derived from bluegrass grasslands, including grain sorghum, sunflowers, mungbeans and wheat as well as forage sorghum and oats. It is difficult to judge the aerial extent of the threat of cropping expansion to the bluegrass EC as it is possible that much of the land realistically suited to cultivation for cropping has already been converted to this purpose.

4. Persistent heavy grazing is a pressing threat to the bluegrass grassland EC because grazing is the predominant use to which remnant grassland is subject and:

- persistent heavy grazing can degrade grasslands and greatly increases the risk of weed invasion; and
- some threatened bluegrass grassland plants and animals are not favoured by grazing.

Grazing management should focus on maintaining the most palatable perennial species, such as Queensland bluegrass or king bluegrass, and carrying vegetation cover through the driest years. This generally means reducing cattle stocking rates from a typical year round average of around one cattle equivalent to 11 acres (4.5ha, Barrett and Bishop 2000) to something closer to 20 acres (8ha) per head, as well as spelling grasslands during the summer growing season as often as possible (wet season spelling). Management of stock routes and travelling stock reserves should also follow the practice of minimising grazing pressure on bluegrass grasslands during the summer growing season. It is essential that grazing of endangered bluegrass grasslands in stock routes and travelling stock reserves is well managed and closely monitored.

Degraded paddocks appear to be particularly sensitive to grazing pressure, and even very low grazing pressure is sufficient to perpetuate degradation in grassland. Complete de-stocking in the short to medium term is recommended in degraded areas, especially following summer rain, at least until key palatable perennial grasses are re-established. Weed management may become an issue in such situations. Advice on appropriate weed management is available through the Department of Natural Resources, Mines and Water in Queensland and the Department of Natural Resources in New South Wales. Marsupial grazing pressure, and identifying appropriate management options for this pressure, can be a serious issue for some landholders attempting to spell paddocks and more closely manage grazing pressure (eg. case studies in Chamberlain and Gittens 2004).

When bluegrass grasslands are a small part of a paddock containing a mixture of land types they are at risk of degradation by preferential grazing. Fencing according to land type is strongly recommended to improve the management and condition of grasslands in such situations. For this reason, incentive schemes to help landholders with the cost of fencing bluegrass grasslands out of mixed country paddocks would be useful.

5. Invasive species threaten the value of bluegrass grasslands as habitat for native organisms and also often diminishes their pastoral value. Invasive animals that use bluegrass grasslands include rabbits, pigs, cats, foxes, and dogs, as well as birds such as common starlings and Indian mynas. The most abundant animal pest found in grasslands is the house mouse (*Mus musculus*). The house mouse potentially competes with native small mammals, reptiles and birds such as quail, and may impact upon seed production and recruitment by some plants. The house mouse is also an important food resource for grassland specialist predators such as the black-shouldered kite (*Elanus axillaris*), Australian kestrel (*Falco cenchroides*), barn owl (*Tyto alba*) and spotted black snake (*Pseudechus guttatus*), as well as predators with more generalist habitat preferences such as eastern brown snake (*Pseudonaja textilis*) (Hobson 2002). There is very little information available on the impact of pest animals on bluegrass grassland's environmental or pastoral values.

Most invasive plants require some form of disturbance to invade healthy bluegrass grasslands. However, disturbances also include drought, fire, carefully managed grazing and the activities of native animals, and over the longer term weed invasion may occur without being facilitated by management. Many weed species will mostly occur as scattered plants and rarely reach plague proportions without severe disturbance (eg. Mexican poppy, *Argemone ochroleuca*). Some weeds, such as the exotic grasses listed in relation to road works, are primarily disturbance dependent for establishment in bluegrass grasslands, but hold onto sites very tenaciously following invasion.

Recent experience in the Central Highlands suggests that buffel grass is establishing populations on heavy black clay soils to which it had previously appeared unsuited. Buffel grass has also come to dominate the ground stratum in many areas of mountain coolibah (*Eucalyptus orgadophila*) woodland, which often form a landscape mosaic with bluegrass grasslands. The invasion of these woodlands, which grow on slightly lighter and redder clay soils higher in the landscape, has implications for the biota of the bluegrass grasslands because the mountain coolibah woodlands used to provide additional habitat for many plants of bluegrass grasslands. In other words, invasion of woodlands by weedy grasses increases the overall pressure on many threatened grassland species.

The Weeds of National Significance include three species that threaten the bluegrass EC: parthenium (*P. hysterophorus*), parkinsonia (*Parkinsonia aculeata*) and prickly acacia (*Acacia nilotica* subsp. *indica*). Parkinsonia and prickly acacia are prickly

leguminous shrubs. Parkinsonia is primarily a floodplain weed that threatens mainly the alluvial component of the bluegrass EC (RE 11.3.21) in the north, particularly adjacent dams. Prickly acacia currently occurs in the Central Highlands, around Clermont, and is climatically suited to clay soils over large areas of the Brigalow Belt bioregion (Spies and March 2004).

Some native woody weeds can also threaten the integrity of bluegrass grasslands. Such plants are often a natural part of bluegrass grasslands and intervention is only warranted where they present a clear threat to grassland integrity. Sally wattle (*Acacia salicina*, a.k.a black wattle) appears to be a particularly problematic species in the Central Highlands but mimosa (*Acacia farnesiana*) can also form dense thickets. Increasing density of wattles and other woody plants can be a result of fire exclusion. As such, initiation of appropriate fire regimes, particularly following woody weed germination events, is recommended as the preferred method to manage woody plant densities in grasslands. Fire may initially stimulate germination from the seed bank, resulting in more *A. salicina* after the first fire than before it. However, subsequent fires can reasonably be expected to slowly reduce the soil seed bank as well as killing some established plants, and eventually provide some control. Identifying appropriate fire regimes beyond broad guidelines (eg. time fires to avoid exposing bare ground for extended periods, or to follow woody plant germination events), will require an adaptive approach from managers and would also benefit from specific research. Where dense and extensive stands of mature wattles or other shrubs are threatening the viability of high value grasslands (eg. in stock routes) chemical or physical control may be required to re-establish grassland structure, after which more frequent burning may be adequate to keep their density low.

Weed invasion is a complex issue involving a large number of invasive plants. The basic principles of minimising disturbance, maintaining high grass cover, and allowing regular opportunities for native seed bank and plant reserve replenishment, offer the best chance for rapid recovery from unavoidable disturbance, and resistance to weed invasion. However, some particularly invasive species such as lippia (*Phyla canescens*) may still cause problems, which means that regular monitoring and early response to invasive species is important for grassland managers. For example, bluegrass grassland remnants in stock routes on the Darling Downs are of the highest significance to the bluegrass EC and are threatened by several serious weed species. Active and ongoing monitoring is strongly recommended in such situations to allow a rapid response to new incursions by weed species. Early intervention is well established as the most cost effective strategy in weed management.

6. Construction of roads and other infrastructure is a very significant threat to grasslands because:

- the Darling Downs bluegrass grasslands are a significant subtype of the bluegrass grassland EC which have been cleared to about 1 percent of their original extent, much of which occurs in road reserves; and,
- bluegrass grasslands in road reserves and rail corridors provide essential habitat for grazing intolerant flora and fauna. Grazing by domestic stock is a pervasive influence in remnant grasslands and some species (eg. *Trioncinia retroflexa*) are so sensitive to grazing that infrequently grazed bluegrass grassland (such as road and rail reserves) is frequently of the highest conservation value.

Road widening and associated construction of culverts, drainage lines, stock-piles, site offices and turning circles destroy grassland cover, and therefore directly damage the ecosystem and also increase the likelihood of weed invasion and soil erosion. Importation of rock and soil and mechanical disturbance associated with road work frequently enables invasion by exotic grasses such as Columbus grass (*Sorghum x*

almum), Johnson's grass (*Sorghum halepense*), African lovegrass (*Eragrostis curvula*), Rhodes grass (*Chloris gayana*), buffel grass (*Cenchrus ciliaris*), green panic *(Megathyrsus maximus*), paspalum (*Paspalum dilatatum*) and rat's tail grasses (*Sporobolus natalensis* and *S. pyramidalis*). Slashing and movement with stock helps to spread these grasses and they are very difficult to eradicate once established.

Unnecessary slashing occurs on some broad areas of stock routes on roadsides. Although slashing has potential to spread weeds it probably has limited impact on the bluegrass grassland EC provided it is restricted to the already disturbed road verge (within a few metres). Persistent slashing of larger areas of remnant bluegrass grasslands, particularly on roadsides on the Darling Downs, certainly alters their value as habitat for cover dependent fauna (Hobson 2002) and is also likely to increase the risk of weed invasion by spreading propagules and providing open space for weed establishment. Frequent slashing may also inhibit flower and seed production by taller plants and could result in compositional changes over the long term (a few years to a decade).

7. Lack of knowledge about complex issues such as climate change, the detailed ecology of threatened species, weed invasion and fire regimes means that we could be overlooking some threats to the bluegrass grasslands in the Brigalow Belt. A strategic approach to development of knowledge about the grasslands should involve detailed studies of the ecology of the relevant common and threatened species, as well as formalised and appropriately funded monitoring programs and management research to assess trends in condition and function.

Threatened species (listed in Table 2) are candidates for ecological research however reliable knowledge of even quite common species is generally poorly known. Even some of the rarest and most charismatic creatures such as the grassland earless dragon (*Tympanocryptis pinguicolla*) are poorly known. The ecology of the related, lined earless dragon (*Tympanocryptis lineata*) on grasslands in the Central Highlands probably also needs study. The ecology of Queensland bluegrass and King bluegrass should certainly be more closely examined, particularly since their palatability may make them useful as indicators for sustainable grazing management. Survey and ecological work is also clearly needed on other rare and poorly known species that are not currently listed as threatened, such as downs Cymbonotus (*Cymbonotus maidenii*), plains Picris (*Picris barbarorum*) and Dalton weed (*Senecio daltonii*).

Although rare species deserve research attention, documented understanding of key grassland components, including common species such as *Dichanthium sericeum* and other dominant perennial grasses and key legumes, is also inadequate. Detailed work on key grassland species and community level studies will increase and test our knowledge of the ecosystem as a whole.

Populations under threat

Not all populations are equally threatened by all of the threatening processes, for example the threat of road and infrastructure construction is more likely for the high priority grasslands in road and rail reserves, stock routes and travelling stock reserves.

Table 3. Threats summary

Type of threat	Current actions to reduce threats	Future actions to reduce threats
Expansion of exotic pastures and tree crops	Protection under EPBC Act. Protection under nature-refuge agreements and other reserves. Sustainable grazing management.	Encourage sustainable grazing management of native species. Ensure relevant proposed future land management actions are referred under the EPBC Act.
Expansion of mining activities	Protection under EPBC Act. Protection under nature-refuge agreements.	Ensure relevant proposed future land management actions are referred under the EPBC Act. Negotiated conservation agreements. Purchase land for addition to protected area estate.
Expansion of cultivation for cropping	Protection under EPBC Act. Protection under nature-refuge agreements and other reserves.	Ensure relevant proposed future land management actions are referred under the EPBC Act. Negotiated conservation agreements. Purchase land for addition to protected area estate.
Persistent heavy grazing	Extension work by DPI&F and others to encourage and empower landholders to adopt sustainable grazing practices.	Financial support or incentives for best practice grazing management and more resources for extension by DPI&F.
Invasive species	Considerable effort is already made to control weedy plants and pest animals by landholders and numerous government and non-government agencies. DPI&F extension often identifies prevention of weed invasion as a major benefit from sustainable grazing practices.	Avoid propagation or promotion of invasive exotic species. More resources to encourage sustainable grazing practices. Control slashing where appropriate. Research into problematic pest animals and invasive plants (including natives), and their control.
Construction of roads and other infrastructure	Mining companies, Shire Councils, Main Roads and Queensland Transport have environment officers and protocols in place to minimise impact on endangered vegetation.	Reinforce importance of roadside grasslands to relevant agencies. Periodic survey of roadsides to provide up-to-date information on the distribution of high value grasslands to relevant agencies.
Lack of knowledge	Considerable previous research as well as informal monitoring by landholders and biologists.	Further research into detailed ecology of key ecosystem components and threatened species. Including fire ecology, recruitment and mortality. Establish strategic monitoring.

4. Objectives and criteria

The following objectives, criteria and actions are included here as starting points for discussion.

Overall objective
Maintain and conserve the environmental and pastoral values of the bluegrass grasslands in the Brigalow Belt over the long term, by minimising the loss of bluegrass grasslands in the Brigalow Belt and improving their condition and management.

Specific objectives
S.O. 1 Maintain all areas of the bluegrass grassland EC in subregions in which its extent is 30 percent or less of its pre-clearing extent and, in other subregions, maintain areas of the bluegrass EC that are either known habitat for threatened species, are infrequently grazed, or are larger than 50ha.
S.O. 2 Improve the condition of bluegrass grasslands across the Brigalow Belt.
S.O. 3 Maintain or enhance populations and knowledge of threatened flora and fauna from bluegrass grasslands, such as grazing sensitive plants.
S.O. 4 Improve knowledge of key ecosystem components, such as perennial grasses and legumes, and identify appropriate management practices that will contribute to S.O. 2.

Performance criteria
Progress toward the objectives of this plan can be measured against the following performance criteria:
C 1 The area of the bluegrass grassland EC in extensively developed subregions (30 percent or less of EC's pre-clearing extent remaining) does not decline, and no remnant areas 50 ha or larger, or known to support threatened species, or in infrequently grazed situations (such as on public land) are cultivated, mined or otherwise rendered non-remnant between 2007 and 2011.
C 2.1.1 Fencing and water infrastructure in grazed portions of the bluegrass EC is modified to better integrate the ecological needs of the grasslands into grazing management, principally for spelling during the growing season.
C 2.1.2 Greater frequency of palatable perennial grasses in 2011 than in surveys conducted in February-March 2005.
C 2.2 Improved condition of grasslands on stock routes, travelling stock reserves, and road and rail corridors in the Central Highlands and on the Darling Downs.
C 3.1 Monitoring established for selected populations of Belyando cobblers-peg (*Trioncinia retroflexa*), Dalton weed (*Senecio daltonii*), downs Cymbonotus (*Cymbonotus maidenii*), finger panic grass (*Digitaria porrecta*), five-clawed worm skink (*Anomalopus mackayi*), grassland earless dragon (*Tympanocryptis pinguicolla*), king bluegrass (*Dichanthium queenslandicum*), poppy-leaf nightshade (*Solanum papaverifolium*), plains Picris (*Picris barbarorum*) and winged nightshade (*Solanum stenopterum*) across the EC and these populations are extant in 2011.
C 3.2 Increased knowledge of the ecology threatened species, documented in peer-reviewed publications.
C 4.1 Increased knowledge of the ecology of key ecosystem components and their responses to common management practices documented in peer-reviewed publications and summarised into public information resources.

Evaluation of recovery plan
The plan will be reviewed at intervals no longer than five years. Implementation will be reviewed by relevant experts and should include a cost–benefit analysis to identify those actions that deliver value.

5. Recovery actions

The implementation of the following recovery actions needs co-operation with landholders managing bluegrass grasslands. In many cases existing management is adequate, explaining the presence of diverse grasslands or the persistence of healthy populations of threatened species. Where actions are recommended they may require external resources beyond the responsibilities of landholders. The costs associated with these actions are total estimates for 5 years and the real cost will depend upon how they are implemented and how well they are taken up.

Action 1.1 Promote landholder awareness of sustainable management practices and their importance to the preservation of bluegrass grasslands' environmental and pastoral values.

Field days aimed at people with an interest in bluegrass grasslands, including landholders and government officers, should be conducted to demonstrate well managed grasslands in good condition and to provide a forum for extension of best practice grassland management. Some landcare groups are already conducting such field days. Field days would ideally include the experience of extension and research officers of the Department of Primary Industries and Fisheries. Field days will also progress some of the other proposed actions including encouragement toward nature refuge agreements (A 1.2) and discussion of sustainable grazing management (A 2.1.1 and A 3.2). The DPI&F's "Stocktake Grazing Land Management" package (Aisthorpe and Paton 2004, Open Downs land type) provide a useful framework within which to promote best practice grazing management of bluegrass grasslands.

Potential contributors: Natural Resource Management Regional Bodies, AgForce, Queensland Farmers Federation, Queensland Resources Council, Queensland Department of Primary Industries and Fisheries, Queensland Environmental Protection Agency/Queensland Parks and Wildlife Service, and Queensland Department of Natural Resources, Mines and Water.

Cost: $20 000

Action 1.2. Encourage landholders to enter into conservation agreements over bluegrass grasslands.

Negotiation of voluntary conservation agreements, such as Nature Refuges, which attach to the title and cover all or part of a parcel of land, can be mutually beneficial for landholders and biodiversity. Landholders with Nature Refuges are eligible for the Environmental Protection Agencies' NatureAssist program. NatureAssist provides a number of incentives, including funding for management assistance, such as fencing and eradication of weeds and pests. In addition, landholders may be entitled to benefits such as reimbursement of Stamp Duty and Land Tax, and may be advantaged in seeking grants for conservation works (eg. fencing, watering points) through Natural Resource Management Regional Bodies.

QPWS Extension Officers undertake property assessments, negotiate the Nature Refuge Agreement and provide follow-up advice and assistance with management. Relevant aims for Nature Refuges over bluegrass grasslands might include low intensity stock grazing with regular rest in the growing season, as well as effort to remove or contain any localised infestations of invasive plants such as buffel grass, and avoid introducing new weeds into the grassland (eg. on vehicles or in stock guts). Flora and fauna surveys would be conducted initially when preparing to enter a Nature Refuge Agreement and should be repeated periodically to gauge the affect of management.

Potential contributors: Queensland Environmental Protection Agency/Queensland Parks and Wildlife Service, Natural Resource Management Regional Bodies, Queensland Department of Natural Resources, Mines and Water, and Australian Government Department of the Environment and Heritage.

Cost: $50 000

Action 1.3 Increase the area of bluegrass grassland in the conservation estate.

The bluegrass grassland EC is poorly represented in the National Park estate (2% of remnant area). Increasing the area of bluegrass grassland in the protected area estate avoids the conflict between production and conservation values present across most of the landscape. Alluvial grasslands (Regional Ecosystem 11.3.21) have been extensively cultivated and are particularly poorly reserved. Grasslands on Cainozoic clay plains are also very poorly reserved. There may also be opportunities to reserve bluegrass/Mitchell grass grasslands that are not part of the EPBC Act listed bluegrass EC but are habitat for many of the same species, such as grasslands with patchy brigalow or coolibah on Cainozoic clay plains (RE 11.4.11) and on fine grained sedimentary rock (RE 11.9.3).

Strategic establishment of populations of threatened flora within existing conservation reserves is also recommended.

Potential contributors: Queensland Environmental Protection Agency/Queensland Parks and Wildlife Service, Natural Resource Management Regional Bodies, Queensland Department of Natural Resources, Mines and Water, and Australian Government Department of the Environment and Heritage.

Cost: $3 030 000

Action 2.1.1 Assist graziers to fence bluegrass grasslands out from other land types and to subdivide bluegrass grasslands to facilitate sound grazing management, including spelling from grazing during critical periods in the summer growing season.

Sustainable grazing management of bluegrass grasslands has mainly been developed and communicated by pasture scientists and extension officers from the Queensland Department of Primary Industries and Fisheries. Extension officers possess knowledge relevant to a very wide range of problems landholders face, including weed management, pasture decline and soil loss. Additional support for these officers in the form of assistance to run field days, production of extension material and information sheets, and most importantly, extra staff to increase the availability of their services, would all benefit grazing management of the bluegrass grasslands.

Field days should be organised to discuss and demonstrate sustainable grazing management of bluegrass grassland, involving graziers, mining environmental officers and other managers of bluegrass grasslands, as well as representatives of regional NRM bodies and government.

Bluegrass grasslands in paddocks mainly of other land-types can be preferentially grazed. The threat of overgrazing can be managed by fencing so that grasslands are major components of the paddocks within which they occur. This will not always be practical but should be encouraged where it is.

Persistent heavy grazing is well understood as a major cause of pasture decline and dominance by unpalatable perennial grasses or weeds. Grassland managers should be encouraged and assisted to strategically spell paddocks during phases of very active

growth during and following wet warm weather. This might require additional watering points, fences or other infrastructure.

Financial support for this action may already be available under initiatives such as the Biodiversity Incentives Tender (administered by Queensland Environmental Protection Agency) or the Australian Government Envirofund (Natural Heritage Trust) and Natural Resource Management Regional Bodies may also have opportunities to help landholders better manage grasslands by these means. Fencing by land type and summer spelling should also be common components of Nature Refuge Agreements or other conservation agreements.

Potential contributors: Commonwealth Department of Environment and Heritage, Queensland Department of Primary Industries and Fisheries, Queensland Department of Natural Resources, Mines and Water, and Natural Resource Management Regional Bodies

Cost: $300 000

Action 2.1.2 Research and develop use of bluegrass grassland species for pasture renovation and land rehabilitation, and encourage mines, main roads and others to use native species in plantings by establishing a seed bank from which seed may be purchased at competitive prices.

Though desirable, the uses to which native pasture species are currently put are limited by the availability and cost of seed and technological know-how regarding its use. Significant progress has been made toward establishing native grass industries in southern Australia but relatively little progress has been made in Queensland.

Natural Resource Management Regional Bodies could help this industry to develop by seeking and funding appropriate proposals. For example, a first step might trial the use of material from healthy bluegrass grasslands to renovate or recover degraded pastures, perhaps by cutting and bailing hay from a healthy bluegrass grassland late in summer (when the grasses are carrying seed) and then spreading the hay over a degraded pasture. Similar trials may be appropriate to restore grasslands subject to physical disturbance such as road works. Other techniques such as seed harvesting and sowing perennial grasses such as Queensland bluegrass also need trialling. The use of native species should be encouraged. The ecology of Queensland bluegrass and other grassland plants certainly suggests they have potential as utility species.

Techniques using native grassland species for restoration or reclamation will develop faster if their use is required by policy and government action. At present exotic grasses such as buffel grass and Rhodes grass tend to be species of choice for reclamation of disturbed areas. This is primarily because the seed of such species is readily available whereas native species are not. Investment is required to address this discrepancy. Establishing a seed bank of key species such as Queensland bluegrass would enable parties with an interest in using natives to purchase seed. Whether potential users will buy seed will often depend upon a reasonably competitive price. Mining companies and other potentially large-scale users of seed may find it in their interest to establish seed reserves themselves and should be encouraged to do so.

Potential contributors: Natural Resource Management Regional Bodies, Queensland Resources Council (and it's members), Queensland Department of Primary Industries and Fisheries, Queensland Department of Main Roads and Queensland Environmental Protection Agency/Queensland Parks and Wildlife Service, CSIRO, Universities.

Cost: $500 000

Action 2.2 Officers to monitor and improve the condition of priority grasslands in stock routes in the Central Highlands and Darling Downs.

Grasslands in stock routes and travelling stock reserves are important parts of the bluegrass grassland endangered ecological community because of their association with infrequent grazing, but they are linear strips with large edge to interior ratios and may be particularly prone to weed invasion and disturbance.

For the Central Highlands, Keith's (2002) survey of stock route grasslands provided a basis for ongoing monitoring and targeted management. It is recommended that at least the priority grassland areas identified by Keith (Table 5) are revisited and permanent monitoring plots are installed. In the process, weed issues in each area should be identified and then systematically addressed. Where signage has not been installed to identify these areas this should be addressed with signs installed at each end of the grassland area. Neighbouring landholders, stock route supervisors and fire wardens should be consulted regarding fire management history and constraints, and where appropriate fire should be applied to portions of the areas and the results monitored. Where low quality areas such as infestations of Columbus grass or Johnson's grass interrupt high quality section of grassland in a stock route they should be targeted for restoration.

On the Darling Downs the stock route grasslands comprise about a third of the bluegrass grassland ecological community's remaining distribution and are therefore of the highest biodiversity significance. Remnant grassland areas on the Darling Downs were mapped by Fensham (1996) and the condition of the four major stock route grasslands was assessed by Goodland (2000), as summarised in Table 6.

Table 5. Priority stock route grassland areas in the Central Highlands (from Keith 2002)

Shire	Road
Belyando Shire	1. Peak Downs highway from the Charters Towers Road turn-off to Wolfang Peak.
	2. Kilcummin-Diamond Downs Road
	3. Clermont-Dysart Road
Peak Downs Shire	1. Gregory Highway at Lilyvale between Freshfields and Lucknow
	2. Gregory Highway at Retro Creek
Emerald Shire	1. Gregory Highway at Fernlees
	2. Cullin-La-Ringo Road
Bauhinia Shire	1. Gregory Highway between the Emerald shire boundary and Minerva Creek
	2. Dawson Highway between Staircase Range and Orion 10 Chain Road
	3. Orion 10 Chain Road between Dawson Highway and Orion State School
	4. Dawson Highway between Bottle Tree Downs Road and Rolleston
	5. Wealwandangie Road

Table 6. Priority stock route grasslands on the Darling Downs (from Goodland 2000)

Stock Route	Description
Warrego Highway (from western end of Oakey bypass to Bowenville)	Wide stock route adjacent rail corridor. Mainly in good condition but threatened by weedy grasses including Rhodes grass and African lovegrass, being spread by slashing. Known habitat for *Anomalopus mackayi, Thesium australe*, *Digitaria porrecta* and first record of *Dichanthium queenslandicum* on Darling Downs since 1951.
Dalby to Jandowae Road (from railway intersection in Dalby to Jandowae)	Wide stock route. Mix of grassland and poplar box woodland. Mainly in good condition but some significant degraded parts.

Dalby to Cecil Plains Road (from 1.8km south of Warrego Highway to 13km NE of Cecil Plains)	Some areas heavily invaded by Lippia (*Phyla canescens*) and others degraded by exotic grasses. Unconfirmed record of *Tympanocryptis pinguicolla* from 1970's. Known habitat for *Cymbonotus maidenii*
Warrego Hwy & Dalby to Kogan Rd. (from 5 km west of Dalby to Condamine River on Kogan Rd.)	Wide stock route with patches in excellent condition and others that have been badly degraded. Known habitat for *Hemiaspis damelii*, *Digitaria porrecta* and *Solanum papaverifolium*

For the Darling Downs, it is recommended that the condition assessment for these priority stock routes reported by Goodland be repeated and permanent monitoring plots installed. In the process, weed issues in each area should be identified and then systematically addressed. Where signage has not been installed to identify these areas this should be addressed, with signs installed at least at each end of the grassland area. Where low quality areas such as infestations of Rhodes grass (*Chloris gayana*) interrupt more natural sections of grassland in a stock route they should be targeted for restoration.

This action would provide a suitable core task for a team of two full-time officers (a researcher and technician), preferably based in Emerald. These officers might be hosted by one of the NRM Regional Bodies or State Government departments but could potentially be funded by several of the numerous stakeholders with substantial areas of bluegrass grassland under their care. Such a team would provide a valuable resource for the other actions proposed, including field days and other research suggestions. This should be an ongoing commitment.

Stock Route Management Plans are currently being prepared for most shires that contain grasslands on stock routes and travelling stock reserves. The monitoring and intervention work proposed in this action will provide opportunities for collaborative work with stock route supervisors, land protection officers, neighbouring landholders and other grassland managers.

Potential contributors: Jondaryan Shire, Wambo Shire, Bauhinia Shire, Belyando Shire, Peak Downs Shire, Emerald Shire, Natural Resource Management Regional Bodies, Queensland Department of Natural Resources and Mines, Queensland Department of Main Roads and Queensland Environmental Protection Agency/Queensland Parks and Wildlife Service.

Cost: $750 000

Action 3.1 Monitor selected populations of Belyando cobblers-peg (*Trioncinia retroflexa*), Dalton weed (*Senecio daltonii*), downs Cymbonotus (*Cymbonotus maidenii*), finger panic grass (*Digitaria porrecta*), five-clawed worm skink (*Anomalopus mackayi*), , grassland earless dragon (*Tympanocryptis pinguicolla*), king bluegrass (*Dichanthium queenslandicum*), poppy-leaf nightshade (*Solanum papaverifolium*), plains Picris (*Picris barbarorum*) and winged nightshade (*Solanum stenopterum*) across the EC, and continue efforts to locate the Retro slider (*Lerista allanae*).

Monitoring established for selected populations of across the EC and these populations are extant in 2011.Sites containing threatened flora and fauna should be identified and subject to ongoing monitoring.

Plant species recommended for monitoring include: Belyando cobblers-peg (*Trioncinia retroflexa*), Dalton weed (*Senecio daltonii*), finger panic grass (*Digitaria porrecta*),

downs Cymbonotus (*Cymbonotus maidenii*), king bluegrass (*Dichanthium queenslandicum*), poppy-leaf nightshade (*Solanum papaverifolium*), plains Picris (*Picris barbarorum*) and winged nightshade (*Solanum stenopterum*). Animal species recommended for monitoring include: five-clawed worm skink (*Anomalopus mackayi*) and grassland earless dragon (*Timpanocryptis pinguicolla*).

Monitoring should be attentive to recovery from fire, grazing or other management interventions and should be set up in collaboration with local stock route supervisors, extension officers and landholders.

High priority should also be given to further attempts to locate populations of the Retro slider (*Lerista allanae*). This burrowing skink was last collected in 1960 and is probably extinct. If extinct, the Retro slider is the only known Australian reptile to have become extinct since 1788.

Potential contributors: Shire councils, Queensland Environmental Protection Agency, Queensland Department of Main Roads, Queensland Department of Natural Resources and Mines, Natural Resource Management Regional Bodies.

Cost: $25 000 (given spending on officers recommended in Action 2.2).

Action 3.2 Research into the basic ecology of key threatened species.
Studies of the ecology of threatened species are a core part of a strategic approach to the development of knowledge about endangered bluegrass grasslands. The grassland earless dragon is poorly known and 'Endangered' and occurs on the Darling Downs while the related lined earless dragon (*Tympanocryptis lineata*) occurs on grasslands in the Central Highlands. Studying the basic habitat requirements, diet, breeding and mortality in both areas would enable better-informed management of its populations and of grasslands more generally. Closer examination of the earless dragons on the grasslands of the Central Highlands is also probably warranted.

The ecology of King bluegrass should also be subject to detailed research. King bluegrass is a highly palatable perennial grass with potential as an indicator species for grazing management, but little is documented about why it is apparently so sensitive to grazing, its breeding biology or its habitat requirements. It would help biodiversity planning to know more about the numerous rare and poorly known species in bluegrass grasslands (examples under A 3.1).

Potential contributors: Universities, Queensland Parks and Wildlife Service, Queensland Environmental Protection Agency, CSIRO.

Cost: $25 000

Action 4.1 Research into the basic ecology of main ecosystem components and their response to common management practices, including a cost-benefit analysis to compare recovery actions.
Our understanding of the ecology of bluegrass grasslands is incomplete. More published information is needed on the response of key ecosystem components (including perennial grasses and legumes but especially fauna), to grazing, fire and invasive species. Research Scientists in the Department of Primary Industries and Fisheries have been working for decades on these issues and should be supported to continue to do so, but more research is also needed into the ecology of the bluegrass grasslands' fauna.

Additional work on economic aspects of bluegrass grassland recovery would also be useful. Although concepts such as improvement in grassland condition and

environmental values are notoriously difficult to quantify in dollar terms, a cost-benefit analysis of the various actions proposed under this plan should be undertaken when it is reviewed in 2011.

Cost: $100 000

Table 7. Recovery summary

Specific objective	Performance criteria	Actions	Priority
S.O. 1 Maintain all areas of the bluegrass grassland EC in subregions in which its extent is 30 percent or less of its pre-clearing extent and, in other subregions, maintain areas of the bluegrass EC that are either known habitat for threatened species, are infrequently grazed, or are larger than 50ha.	C 1 The area of the bluegrass grassland EC in extensively developed subregions (30 percent or less of EECs pre-clearing extent remaining) does not decline, and no remnant areas 50 ha or larger, or known to support threatened species, or in infrequently grazed situations (such as on public land) are cultivated, mined or otherwise rendered non-remnant between 2007 and 2011.	A 1.1 Promote landholder understanding of the importance of sustainable management practices to the preservation of bluegrass grasslands' environmental and pastoral values.	high
		A 1.2. Encourage landholders to enter into conservation agreements over bluegrass grasslands.	med
		A 1.3 Increase the area of bluegrass grassland in the conservation estate.	high
S.O. 2 Improve the condition of bluegrass grasslands across the Brigalow Belt.	C 2.1.1 Fencing and water infrastructure in grazed portions of the bluegrass EC is modified to better integrate the ecological needs of the grasslands into grazing management, principally for spelling during the growing season.	A 2.1.1 Assist graziers to fence bluegrass grasslands out from other land types and to subdivide bluegrass grasslands to facilitate sound grazing management, including rest from grazing during critical periods in the summer growing season.	high
	C 2.1.2 The frequency of palatable perennial grasses is greater in 2011 than it was in surveys conducted in February-March 2005.	A 2.1.2 Research and develop use of bluegrass grassland species for pasture renovation and land rehabilitation, and encourage mines, main roads and others to use native species in plantings by establishing a seed bank from which seed may be purchased at competitive prices.	med
	C 2.2 The condition of grasslands on stock routes in the Central Highlands and on the Darling Downs is improved.	A 2.2 Officers to monitor and improve the condition of priority grasslands in stock routes in the Central Highlands and Darling Downs.	high
S.O. 3 Maintain or enhance populations and knowledge of threatened flora and fauna from bluegrass grasslands, such as grazing sensitive plants.	C 3.1 Monitoring established for selected populations of Belyando cobblers-peg, Dalton weed, downs Cymbonotus, finger panic grass, five-clawed worm skink, grassland earless dragon, king bluegrass, poppy-leaf nightshade, plains Picris and winged nightshade across the EC and these populations are extant in 2011.	A 3.1 Monitor selected populations of Belyando cobblers-peg, Dalton weed, downs Cymbonotus, finger panic grass, five-clawed worm skink, grassland earless dragon, king bluegrass, poppy-leaf nightshade, plains Picris and winged nightshade across the EC, and continue efforts to locate the Retro slider.	med
	C 3.2 Knowledge of bluegrass grasslands and threatened species, documented in peer-reviewed publications, is increased.	A 3.2 Research into the basic ecology of key threatened species.	med
S.O. 4 Improve knowledge of key ecosystem components, such as perennial grasses and legumes, and identify appropriate management practices that will contribute to S.O. 2.	C 4.1 Knowledge of the ecology of key ecosystem components and their responses to common management practice, documented in peer-reviewed publications, is increased.	A 4.1 Research into the basic ecology of main ecosystem components and their response to common management practices, including a cost-benefit analysis to compare recovery actions.	med

6. Management practices

Other than managing to avoid gross physical or biological disruption (such as long wall mining, road works or pasture development) the primary management practice relevant to maintaining endangered bluegrass grasslands in the Brigalow Belt is grazing. For bluegrass grasslands it is recommended that fencing and water infrastructure should be designed to allow responsive stock management and to control grazing pressure on grassland areas in mixed-country paddocks. Grazing management should aim to maintain healthy populations of palatable perennial grasses such as Queensland bluegrass (*Dichanthium sericeum*). Please aim to keep at least 50% of the ground surface covered by grass (droughts permitting), and allow grasslands strategic rest from grazing of two to three months duration, preferably during the summer growing season, especially following rain.

Infrastructure works such as pipeline construction and road works are potential causes of weed dispersal and often provide disturbed ground, which may increase the chance of weed establishment. Avoiding such impacts is recommended, especially in infrequently grazed situations. Where they can't be avoided, care should be taken to minimise weed spread and establishment. Rehabilitation with native grasses should be encouraged.

7. Cost of recovery ($)

Table 8. Recovery cost summary

Action No.	Action description	2007	2008	2009	2010	2011
1.1	Promote landholder awareness	5 000	5 000	5 000	5 000	
1.2	Encourage conservation agreements	15 000	10 000	10 000	10 000	5 000
1.3	Acquisition for conservation estate	10 000	10 000	10 000	3 000 000	
2.1.1	Assistance for improved infrastructure and management	150 000	70 000	50 000	20 000	10 000
2.1.2	research and develop native plant usage and seed bank	100 000	100 000	100 000	100 000	100 000
2.2	Officers to monitor and improve priority stock route grasslands	150 000	150 000	150 000	150 000	150 000
3.1	Monitor selected species[A]	5 000	5 000	5 000	5 000	5 000
3.2	Research into basic ecology of threatened species[A]	10 000	10 000	2 000	2 000	1 000
4.1	Research into basic ecology of key ecosystem components[A]	20 000	20 000	20 000	20 000	20 000

[A]Cost for actions 3.1, 3.2 and 4.1 assume full implementation of action 2.2.

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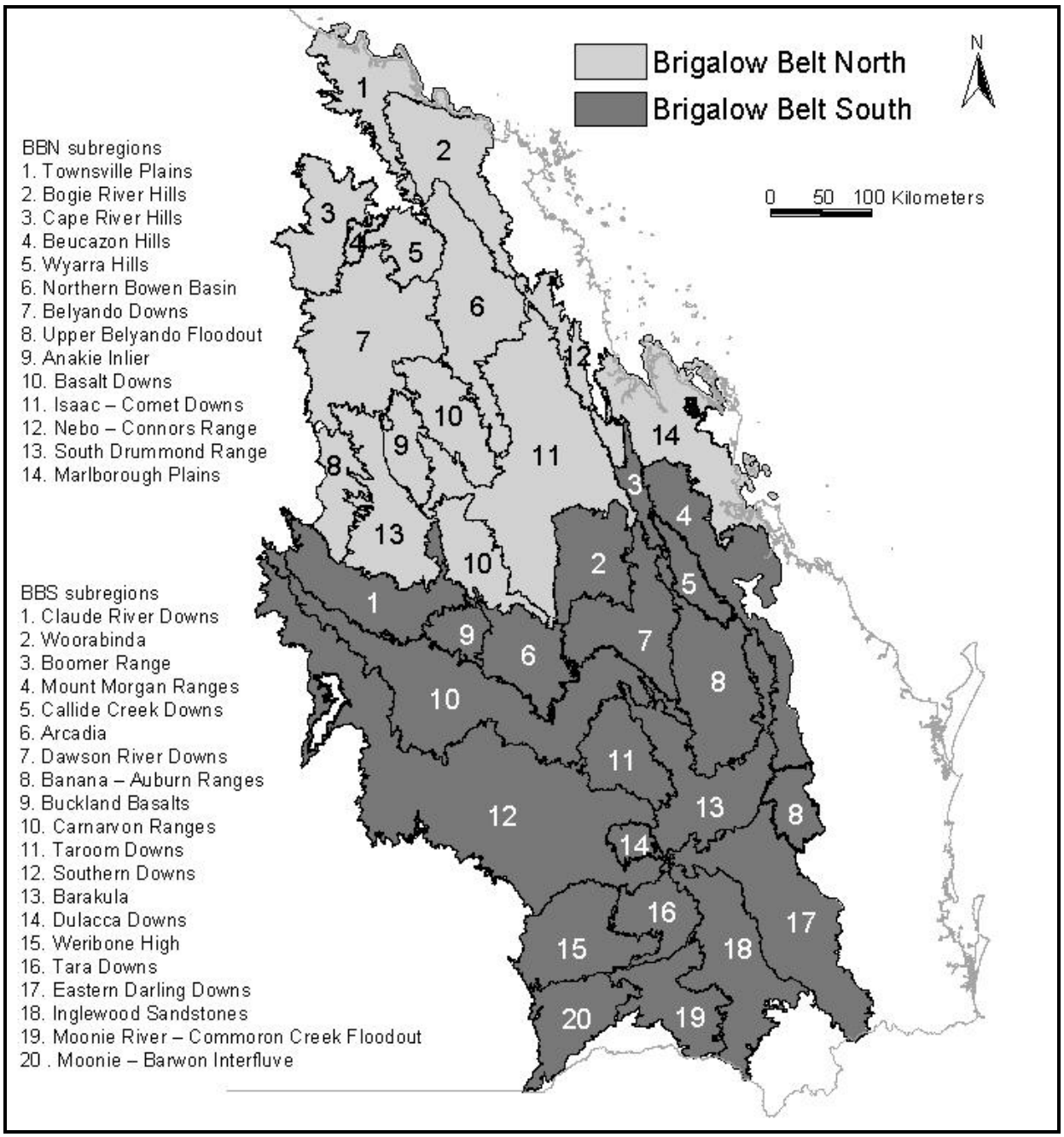
Appendix 1. Pre-clearing and remnant extent of bluegrass grassland EC Regional Ecosystems in the Queensland portions of the Brigalow Belt bioregions.

Values are area in hectares followed by the percentage of pre-clearing area remnant in 2003 in parentheses. Appendix 2 is a map of the subregions.

Subregion	**11.3.21**			**11.4.4**			**11.8.11**			**11.9.12**			% EC
	Pre-clear	2003	cleared 1997-03	Pre-clear	2003	cleared 1997-03	Pre-clear	2003	cleared 1997-03	Pre-clear	2003	cleared 1997-03	remnant in subregion
Brigalow Belt North													
Bogie River Hills				6014	5474 (91%)	-				2260	2224 (99%)	-	93.4
Cape River Hills	150	17 (11%)	-										11.1
Beucazon Hills	446	205 (46%)	-										45.9
Wyarra Hills				82	66 (81%)	-							80.5
Northern Bowen Basin	7322	2323 (32%)	234	1979	171 (9%)	-	28999	20806 (72%)	167	847	688 (81%)	-	61.2
Belyando Downs	6238	2507 (40%)	65	40129	17214 (43%)	324	209	4 (2%)	27				42.3
Upper Belyando Floodout	268	33 (12%)	2				1868	1838 (98%)	30				87.6
Anakie Inlier							997	7 (1%)	2				0.7
Basalt Downs	14572	8868 (61%)	284	4726	1112 (24%)	9	490239	147260 (30%)	6889	172	54 (31%)	5	31.3
Isaac - Comet Downs	7848	1252 (16%)	218	10946	1927 (17%)	57	17120	2727 (16%)	189	555	0 (0%)	-	16.2
Nebo - Connors Ranges	275	138 (50%)	26										50.1
South Drummond Basin	2663	469 (18%)	19	317	98 (31%)	-	270	191 (71%)	33				23.3
Brigalow Belt South													
Claude River Downs	26678	15797 (59%)	1220	781	658 (84%)	-	565	462 (82%)	-	77	66 (85%)	-	60.4
Woorabinda							1450	106 (7%)	-				7.3
Callide Creek Downs	829	0 (0%)					2	0 (0%)					0
Arcadia	2165	28 (1%)	-	272	0 (0%)	-	430	37 (9%)	-	1337	74 (6%)	14	3.3
Dawson River Downs	4936	119 (2%)	18	3823	365 (10%)	25	1266	18 (1%)	-	13717	720 (5%)	221	5.1
Banana - Auburn Ranges	1203	42 (4%)	-				52	0 (0%)	-	291	1 (0%)	-	2.8
Buckland Basalts	703	378 (54%)	-				1737	1697 (98%)	11	135	12 (9%)	9	81.0
Carnarvon Ranges	1423	832 (58%)	156				1015	224 (22%)	-				43.3
Taroom Downs										639	0 (0%)	-	0
Southern Downs	2599	2435 (94%)	15				1944	1697 (87%)	29				91.0
Barakula	57	0 (0%)	-							4555	532 (12%)	22	11.5
Weribone High	24	24 (100%)	-										100
Eastern Darling Downs	384587	4107 (1%)	314	139	0 (0%)	-							1.1
Total	464986	39574 (9%)	2916	69208	27085 (39%)	415	548163	177074 (33%)	7380	24585	4371 (18%)	271	22.6



Appendix 2. Subregions of Queenslands Brigalow Belt Bioregions.

The Brigalow Belt as applied here follows the Interim Biogeogrphic Regionalisation for Australia (IBRA version 5.1, Thackway and Cresswell 1995). The definition used for the Regional Ecosystem framework in Queensland (Sattler and Williams 1999) differs slightly from IBRA by including the northern sections of IBRA's Darling Riverine Plains bioregion, which are excluded here.

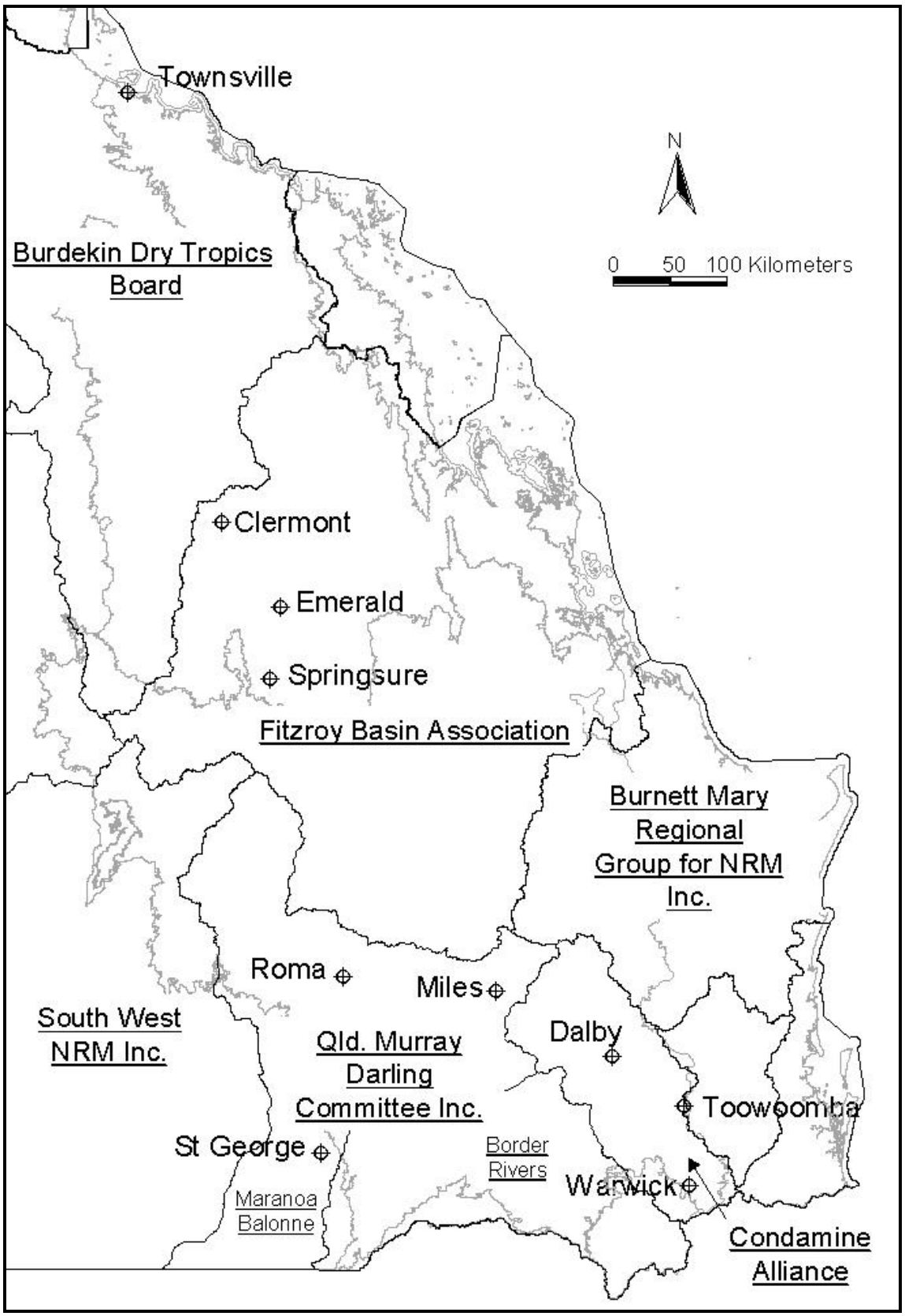
Appendix 3. Local government areas supporting more than 10ha of mapped remnants of the bluegrass grassland EC in 2003.

Values are 2003 remnant extent (hectares), arranged by tenure.

Shire	Freehold	Leasehold	National Park	State Forest	Other	Total
Bauhinia	46622	26081	5352	163	535	78753 (40%)
Belyando	42033	14014	488	17	216	56768 (29%)
Peak Downs	28971	7430	3		171	36575 (27%)
Emerald	16730	6321		30	25	23106 (29%)
Nebo	4039	12630			30	16699 (70%)
Broadsound	8988	3086	33		26	12133 (36%)
Bowen	2007	8646				10653 (82%)
Murweh		3212	70		1	3283 (82%)
Booringa	1814	355	205		10	2384 (69%)
Wambo	1200	997			11	2208 (2%)
Jericho		2102				2102 (71%)
Tambo		1386		2		1388 (93%)
Jondaryan	980	327			22	1329(1%)
Taroom	537	762		30	0	1329 (16%)
Duaringa	470	104		5	14	593 (4%)
Banana	287	35		8	0	330 (3 %)
Dalrymple		253				253 (15%)
Rosalie	181	34			0	215 (1%)
Clifton	146	1			0	147 (0.4%)
Pittsworth	136	2	0		2	140 (0.3%)
Millmerran	97	15			2	114 (0.3%)
Warroo	24					24 (100%)
Warwick	19	2			1	22 (0.1%)
Bungil	14	2				16 (11%)
Cambooya	16	0			0	16 (0.1%)
Total	153187	87797	6151	255	1069	248459

Appendix 4. Extent (hectares) of mapped 2003 remnants of the bluegrass grassland EC by Natural Resource Management Body area and tenure.

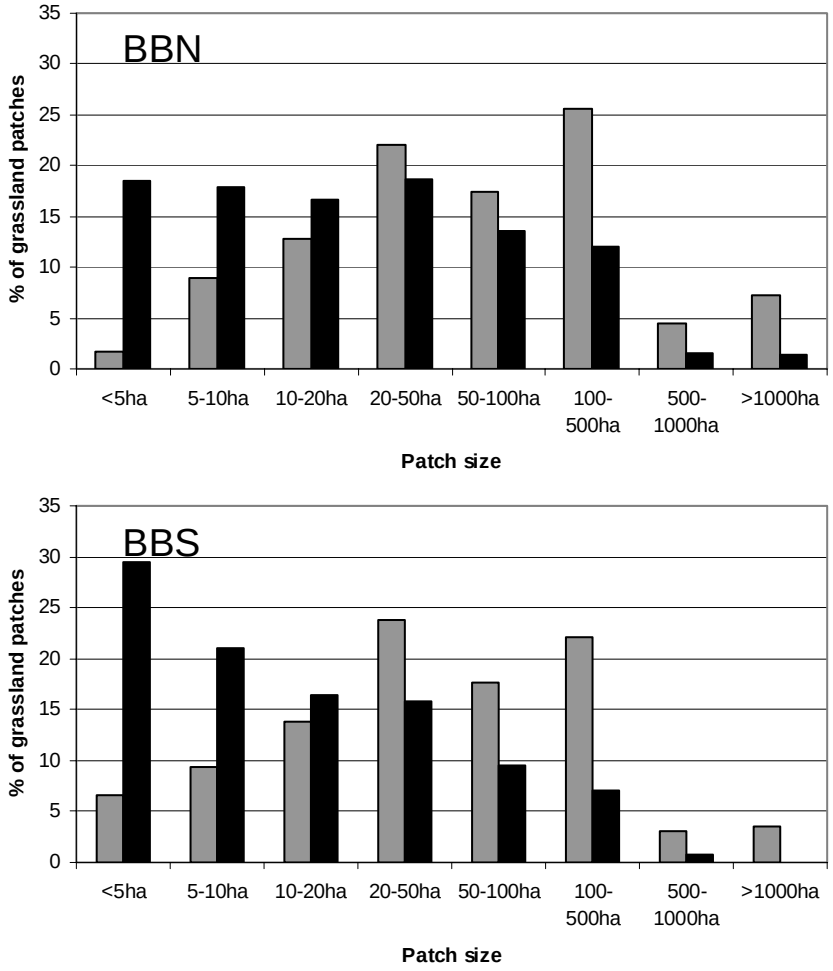
Regional NRM Body	Freehold	Leasehold	National Park	State Forest	Other	Total
Fitzroy Basin Association	118506	50342	5509	223	795	175375
Burdekin Dry Tropics Board	30305	30825	367	17	119	61633
Queensland Murray Darling Committee Inc (Maranoa Balonne NHT section)	1699	345	208		10	2262
Condamine Alliance	2684	1385			37	4106
South West NRM Inc		3210	67			3277
Desert Channels Queensland Inc		1356				1356
Total	153194	87463	6151	240	961	248009



Appendix 5. Queensland's Natural Resource Management Regional NRM Bodies.

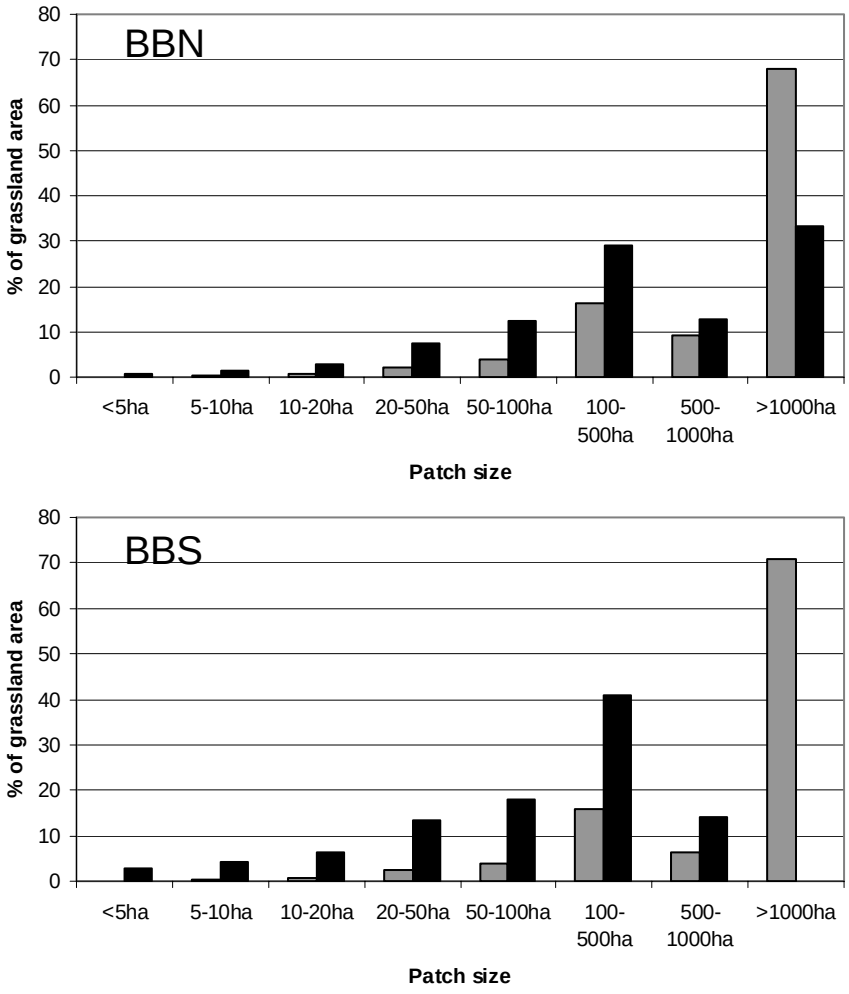
Appendix 6. Extent of mapped remnants (as at 2003) for the bluegrass grassland EC in State Forests and Conservation Reserves.

Reserve	Area (ha) and RE
Albinia Downs National Park	5277 (11.8.11)
Peak Range National Park	521 (11.8.11)
Carnarvon National Park	150 (11.3.21) + 191 (11.8.11)
Mount Hope State Forest	124 (11.8.11)
Nandowrie State Forest	37 (11.3.21)
Theodore State Forest	29 (11.8.11)
Fairbairn State Forest	27 (11.8.11)
Blair Athol State Forest	17 (11.8.11)
Minerva Hills National Park	14 (11.8.11)
Dawson Range State Forest	5 (11.8.11)



Appendix 7. Frequency distribution for classes of bluegrass grassland EC patch size for the Brigalow Belt North (BBN) and Brigalow Belt South (BBS) bioregions

Figures based on pure grassland polygons from Qld Herbarium mapping. Pre-clearing (grey bars) and 2001 (black bars),



Appendix 8. Percentages of the total area of bluegrass grassland EC occurring in patches of different sizes for the Brigalow Belt North (BBN) and Brigalow Belt South (BBS) bioregions.

Based on pure grassland polygons from Qld Herbarium mapping. Pre-clearing (grey bars) and 2001 (black bars).

Appendix 9. Scientific names and authors for plant common names

Common name	***Scientific name* (* denotes introduced species)**
African lovegrass	**Eragrostis curvula* (Schrad.) Nees
Austral cornflower	*Stemmacantha australis* (Gaudich.) Dittrich.
Austral toadflax	*Thesium australe* R.Br.
bambatsi panic	**Panicum coloratum* L.
Belyando cobblers-peg	*Trioncinia retroflexa* (F.Muell.) Veldcamp
bladder ketmia	*Hibiscus trionum* L.
buffel grass	**Cenchrus ciliaris* L.
butterfly pea	**Clitoria ternatea* L.
Columbus grass	**Sorghum x almum* Parodi
coolibah grass	*Thellungia advena* Stapf ex Prost
cow vine	*Ipomoea lonchophylla* J.M.Black
creeping bluegrass	**Bothriochloa insculpta*(Hochst. ex A.Rich.) A.Camus
creeping tick trefoil	*Desmodium campylocaulon* F.Muell. ex Benth.
curly Mitchell grass	*Astrebla lappacea* (Lindl.) Domin
Dalton weed	*Senecio daltonii* F.Muell.
downs Cymbonotus	*Cymbonotus maidenii* (G.Beauverd) A.E.Holland & V.A.Funk
finger panic grass	*Digitaria porrecta* S.T.Blake
grassland sedge	*Cyperus clarus* S.T.Blake
green panic	**Megathyrsus maximus* B.K.Simon & S.W.L.Jacobs
hairy anchor plant	*Discaria pubescens* (Brongn.) Druce
hawkweed	*Picris evae* Lack
hoop Mitchell grass	*Astrebla elymoides* F.Muell ex F.M.Bailey
Indian bluegrass	**Bothriochloa pertusa* (L.) A.Camus
Johnson's grass	**Sorghum halepense* (L.) Pers.
king bluegrass	*Dichanthium queenslandicum* B.K.Simon
leucaena	**Leucaena leucocephala* (Lam.) de Wit
lippia	**Phyla canescens* (Kunth) Greene
lobed bluegrass	*Bothriochloa biloba* S.T.Blake
Mexican poppy	**Argemone ochroleuca* Sweet
mountain coolibah	*Eucalyptus orgadophila* Maiden & Blakely
native millet	*Panicum decompositum* R.Br.
native sensitive plant	*Neptunia gracilis* Benth.
parkinsonia	**Parkinsonia aculeata* L.
parthenium	**Parthenium hysterophorus* L.
paspalum	**Paspalum dilatatum* Poir.
plains Picris	*Picris barbarorum* Lindl.
poppy-leaf nightshade	*Solanum papaverifolium* Symon
prickly acacia	**Acacia nilotica* subsp. *indica* (Benth.) Brenan
purple pigeon grass	**Setaria incrassata* (Hochst.) Hack.
Queensland bluegrass	*Dichanthium sericeum* (R.Br.) A.Camus
rats tail grasses	**Sporobolus natalensis* (Steud.) T.Durand & Schinz and **Sporobolus pyramidalis* P.Beauv.
Rhodes grass	**Chloris gayana* Kunth
satintop	*Bothriochloa erianthoides* (F.Muell.) C.E.Hubb.
sweet summer grass	**Moorochloa eruciformis* (Sm.) Veldkamp.
white speargrass	*Aristida leptopoda* Benth.
winged nightshade	*Solanum stenopterum* A.R.Bean
woolly fuzzweed	*Camptacra barbata* N.T.Burb
Yabilla grass	*Panicum queenslandicum* Domin

Appendix 10. Scientific names and authors for animal common names

Common name	Scientific name (* denotes introduced species)
Australian bustard	*Ardeotis australis* Gray
Australian kestrel	*Falco cenchroides* Vigors & Horsfield
barn owl	*Tyto alba* Scopoli
black-shouldered kite	*Elanus axillaris* Latham
brown falcon	*Falco berigora* Vigors & Horsfield
brown quail	*Coturnix ypsilophora* Bosc
brown songlark	*Cincloramphus cruralis* Vigors & Horsfield
cat	**Felis catus* Linnaeus
common dunnart	*Sminthopsis murina* Waterhouse
common planigale	*Planigale maculata* Gould
dog	**Canis familiaris* Linnaeus
eastern brown snake	*Pseudonaja textiles* Dumeril, Bibron & Dumeril
five-clawed worm skink	*Anomalopus mackayi* Greer & Cogger
fox	**Vulpes vulpes* Linnaeus
golden-headed cisticola	*Cisticola exilis* Vigors & Horsfield
grassland earless dragon	*Tympanocryptis pinguicolla* Mitchell
grey snake	*Hemiaspis damelii* Gunther
house mouse	**Mus musculus* Linnaeus
Indian myna	**Acridotheres tristis* Linnaeus
lined earless dragon	*Tympanocryptis lineata* Peters
little button-quail	*Turnix velox* Gould
long tailed planigale	*Planigale ingrami* Thomas
narrow-nosed planigale	*Planigale tenuirostris* Troughton
pale field rat	*Rattus tunneyi* Thomas
pig	**Sus scrofa* Linnaeus
rabbit	**Oryctolagus cuniculus* Linnaeus
red-chested button-quail	*Turnix pyrrhothorax* Gould
Retro slider	*Lerista allanae* Longman
rufous songlark	*Cincloramphus mathewsi* Iredale
salmon-striped frog	*Limnodynastes salmoni* Steindachner
spotted black snake	*Pseudechis guttatus* De Vis
spotted harrier	*Circus assimilis* Jardine & Selby
common starling	**Sturnus vulgaris* Linnaeus
stubble quail	*Coturnix pectoralis* Gould