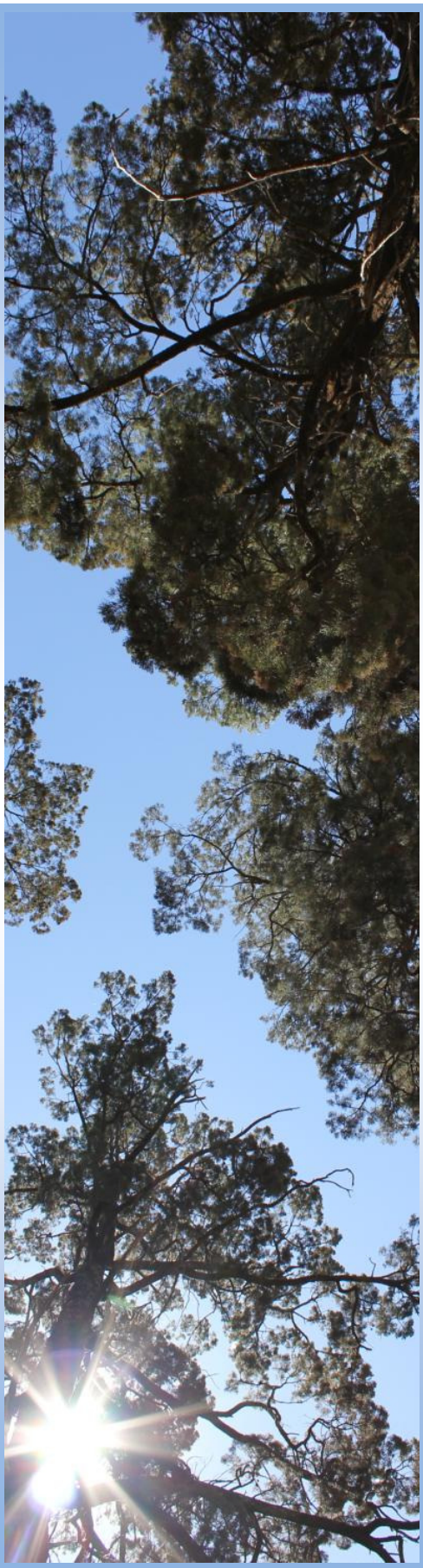

2012 Estcourt Offset Area Monitoring Report

for

Northparkes Mines
North Mining Limited

January 2013

Prepared by DnA Environmental

Disclaimer

This is a report of work carried out by DnA Environmental and on behalf of North Mining Limited's, Northparkes Mines (NPM), Parkes and has been prepared according to the brief provided by the client. The information contained herein is complete and correct to the best of my knowledge. The representations, statements, opinions and advice, expressed or implied in this report are produced in good faith but on the basis that DnA Environmental are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any or all of the content.

Signed:

Dr Donna Johnston
Restoration Ecologist
PhD, B.App.Sc (Hons) MEIANZ

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DnA Environmental
417 Mandurama Rd
Mandurama
NSW 2792

Ph/Fax: (02) 63 675 251
Mobile: 0408 221 922
donna@restorationecologist.com

ABN 19 607 392 634

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Executive summary

The 2011 Estcourt Offset Area (EOA) rehabilitation monitoring report is a result of work carried out by DnA Environmental on behalf of North Mining Limited's, Northparkes Mines (NPM) to satisfy monitoring requirements of the Voluntary Conservation Agreement with Office of Environment and Heritage (OEH formerly Department of Environment, Climate Change and Water (DECCW)). This report describes the results of the annual rehabilitation monitoring program established in the EOA at NPM in 2010 and provides quantified data from representative reference sites as a benchmark for rehabilitation outcomes to assist with the compliance process.

The Estcourt Offset Area is approximately 65ha in area and is situated approximately 2km northeast of the NPM (GHD 2010). The vegetation within the area is comprised of approximately 42 ha of *Eucalyptus microcarpa* (Inland Grey Box) - *E. populnea* (Bimble Box) - *Callitris glaucophylla* (White Cypress Pine) woodland with the remaining 23ha being derived native grassland. The grassy woodland has been subjected to selective thinning and grazing and is now dominated by *Callitris glaucophylla*, with scattered occurrences of *Eucalyptus microcarpa.* Shrubs are scarce but there are several individuals of *Acacia decora* (Western Silver Wattle). The grassy understorey is dominated by a variety of native grasses, herbs and native daisies are common. The derived grasslands have also been described as formerly part of this *E. microcarpa - E. populnea - Callitris glaucophylla* tall woodland but apart from some isolated paddocks trees it has been extensively cleared and has endured a long cultivation and grazing history.

The offset site has been divided into two functional management zones by GHD based on the level of environmental management activities required. Zone 1 (Revegetation Zone) will include rehabilitation of the derived native grasslands through revegetation activities and Zone 2 (Regeneration Zone) will include rehabilitation of existing native vegetation through bush regeneration activities, natural regeneration and supplementary plantings where appropriate.

The monitoring methodology used included a combination of Landscape Function Analyses, accredited soil analyses and various measurements of ecosystem diversity and habitat values based on and adapted from the Biometric methodology and was consistent with that used in previous monitoring years and with the NPM annual rehabilitation monitoring program. Data obtained from within replicated reference woodland site were used to provide upper and lower ecological performance indicator limits. As not all key performance indicators are considered to be fundamental to completion, or in some cases achievable (eg average trunk diameter), key performance indicators have been further separated into "*Completion performance indicators*" and "*Desirable performance indicators"*.

Completion performance indicators are those chosen as completion criteria targets and revegetation sites should equal, exceed or show positive trends towards those attributes of the reference sites. When these completion performance indicators have been met, or trending in the right direction, the sites should therefore theoretically be eligible for closure sign off. The range values of each performance indicator are adapted annually to reflect seasonal conditions and disturbance events. The same five monitoring sites established in the EOA in 2010 were revisited in 2011 and 2012. Vegetation monitoring has been undertaken during spring in all monitoring years and this year was undertaken between 15 – 19th October.

Summary of results

All EOA monitoring sites continued to have a 100% patch area and a Landscape Organisation Index (LOI) of 100% indicating that they continued good ground cover and there was little to no leakage of vital resources such as soil, water, nutrients and seeds. Due to the prolonged dry conditions the ecological performance within numerous sites had declined over the past year but this was also reflected within the reference sites. Nonetheless all sites had an ecological function and soil

characteristics which was comparable to the remnant woodland communities with the exception of the two recovering grassland areas which had low infiltration capacity, organic matter and nitrate levels.

Most changes within the sites were largely due to a declining perennial plant cover with subsequent increases in litter cover and typically there were increased rates of litter decomposition. In numerous sites, the increasing ground cover has resulted in a reduction in erosion and deposition despite the high rainfall activity over the summer period however high levels of ground cover however have tended to result in a general decline in abundance of cryptogams. The increasing states of litter decomposition indicate higher levels of microbial and fungal activity and these are assisting in the development of a humus layer. Increasing levels of humus can reduce soil surface crusting and hardness and this was becoming more evident in several of the more established sites.

Mature trees (>5cm dbh) were only recorded in EOA-04 and EOA-05 however EOA-04 was the only site to meet tree density targets. There was some natural tree and shrub recruitment recorded in all EOA monitoring sites as well as in the reference sites this year however the density of shrubs and juvenile trees was low in all EOA sites. There also needs to be an increase in the diversity of tree species and conservation outcomes could be further enhances by increasing the diversity of shrubs. Many ecological attributes that were not met were largely related to the mature tree population and the structural complexity of the sites due to the lack of a well developed overstorey.

There may have been a slight decrease in total ground cover in some sites as a result of disturbance created by macropods but all EOA sites continued to exceed the minimum KPI target. Total ground cover was derived from various combinations of dead leaf litter, annual and perennial plants and in some sites there were small contribution from cryptogams and logs. There was a reduction in perennial plant cover and annual plants (except in EOA-02) with increases in dead litter cover within all sites. There was an increase in total and native species diversity but typically native species diversity was low in the recovering grassland sites and exotic species were dominant.

This year there were 105 species and of these 31 (30%) were exotic species. Fourteen species were common to all EOA monitoring sites and these included five native perennial grasses including *Austrodanthonia eriantha, Austrostipa scabra subsp. scabra, Chloris truncata, Enteropogon acicularis* and *Sporobolus caroli* and these were also common within the reference sites. Common native herbs included *Calotis cuneifolia*, C. *lappulacea, Vittadinia cuneata var cuneata, Dichondra repens* and *Wahlenbergia gracilis.* Other common natives included *Callitris glaucophylla* and *Carex inversa.* Common weeds were *Echium plantagineum* and *Lolium rigidum* and these were recorded in all EOA sites and were found in some of the reference sites

Conclusion and management recommendations

The Estcourt Offset Area monitoring sites have shown a slight decline in ecological function since 2011 due to the dry seasonal conditions but most sites continued to have a range of ecological traits which were very similar to the surrounding woodland reference sites despite a long disturbance history. Ecological attributes which fell short of meeting the target ranges were largely associated with a low diversity of tree (and shrub) species and in the more disturbed grassland areas, there was low native species richness and exotic species were dominant. There was also a lack of shrubs and juvenile trees in most sites, however natural recruitment was recorded in all monitoring sites as a result of above average rainfall conditions over the summers of 2011 and early 2012.

The proposed revegetation activity within the EOA (GHD 2010) aims to increase biodiversity and habitat values within the EOA through tubestock planting within the more cleared grassland areas and encourage natural regeneration and supplementary planting of shrubs within the more open woodland areas as they are currently limited in abundance and distribution. Areas where natural regeneration is evident should be identified and the methods of revegetation, species and planting densities adapted to

take into account the natural regeneration such that the final woodland communities are comparable with the surrounding remnant woodlands. There were little other management issues that have not already been addressed in the Rehabilitation Management Plan (GHD 2010). Regular slashing of the main access tracks is also advised to allow safe and easy access for maintenance and monitoring of the conservation area.

Natural recruitment was scattered across the EOA site (Above and below)

TABLE OF CONTENTS

1 2012 Estcourt Offset Area Monitoring Report

The 2012 Estcourt Offset Area (EOA) rehabilitation monitoring report is a result of work carried out by DnA Environmental on behalf of North Mining Limited's, Northparkes Mines (NPM) to satisfy monitoring requirements of the Voluntary Conservation Agreement with Office of Environment and Heritage (OEH formerly Department of Environment, Climate Change and Water (DECCW)).

This report describes the results of the annual rehabilitation monitoring program established in the EOA at NPM in 2010 and provides quantified data from representative reference sites as a benchmark for rehabilitation outcomes to assist with the compliance process. The primary objective of the monitoring program is to compare the progress of revegetation areas in fulfilling long-term landuse objectives by comparing a selection of ecological targets or completion criteria against less disturbed areas of remnant vegetation (reference sites) that are representative of the final landuse and vegetation assemblage. The rehabilitation monitoring program has defined a set of completion criteria that are consistent with Northparkes Mines Landscape Management Plan (NPM 2008), community expectations as well as relevant NSW legislation, policies and best practice guidelines (eg. NSW I&I 2010).

Results of the monitoring are first presented in a comparative summary against the woodland reference sites since monitoring began in 2010. The remainder of the report includes detailed descriptions of the monitoring sites, indicating the changes that have occurred between 2010 and 2012 and how they compare to the KPI's.

2 Estcourt Offset Area

A Vegetation Management Plan (VMP) was developed by GHD (2010) which outlines a revegetation strategy for the Estcourt Offset Area. The following description was taken from this VMP.

The objectives of the VMP are to:

- Conserve and improve biodiversity values of the offset site;
- Enhance connectivity with adjacent areas of vegetation;
- Manage the restoration process to ensure the retention of suitable habitat for those threatened and/or significant flora and fauna species present within the offset site and surrounds; and
- Identify opportunities for research and development projects in ecological restoration that assist in mine site [rehabilitation].

The Estcourt Offset Area is approximately 65ha in area and is situated approximately 2km northeast of the NPM (GHD 2010). The vegetation within the area is comprised of approximately 42 ha of woodland with the remaining 23ha derived native grassland. The woodland has been described as *Eucalyptus microcarpa* (Inland Grey Box) - *E. populnea* (Bimble Box) - *Callitris glaucophylla* (White Cypress Pine) tall woodland (GHD 2010) and it contains an unusual occurrence of *E. melliodora* (Yellow Box) on the ridge near an old quarry site. The grassy woodland has been subjected to selective thinning and grazing and is now dominated by *Callitris glaucophylla*, with scattered occurrences of *Eucalyptus microcarpa.* Although the *E. populnea* is present within the woodland, it is not a dominant species and has generally been restricted to small pockets in various locations. The understorey is largely absent with scattered occurrences of Ruby Saltbush (*Enchylaena tomentosa*) and Western Silver Wattle (*Acacia decora*) with the ground cover dominated by native tussock grasses, native herbs and various native daisies.

The derived grasslands have also been described as formerly part of this *E. microcarpa* - *E. populnea* - *Callitris glaucophylla* tall woodland (GHD 2010) but apart from some isolated paddocks trees it has

been extensively cleared and has endured cultivation and grazing. It has been described as highly degraded/cropland (GHD 2010) as well as derived tussock grassland of the central western plains and lower slopes of NSW (DECCW 2010). Despite the agricultural history, GHD (2010) have indicated it retained a moderate diversity of native plants and that it would exhibit some capacity for natural regeneration.

The offset site was divided into two functional management zones based on the level of environmental management activities required. Zone 1 – Revegetation Zone will include rehabilitation of cleared agricultural land through revegetation activities and Zone 2 – Regeneration Zone will include rehabilitation of existing native vegetation through bush regeneration activities, natural regeneration and supplementary plantings where appropriate. Zone 2 shows a higher level of 'natural resilience' than Zone 1.

The VMP outlines the restoration program for these zones and includes details on plant species, planting techniques, revegetation methods and maintenance requirements for the offset site. The revegetation activities will consist of appropriate mixes of canopy, mid-storey and groundcover species representative of the Inland Grey Box Woodland vegetation community listed as an Endangered Ecological Community under the *Threatened Species Conservation (TSC) Act 1995 (NSW).* The restoration program will be the subject of a five year maintenance program that will include watering, weed and feral control, bushfire management and supplementary planting where necessary.

3 Rehabilitation monitoring methodology

The monitoring methodology adopted is a standard and simple procedure that can be easily replicated over any vegetation community or rehabilitation area and importantly results in a system that essentially compares "apples with apples". The monitoring project aimed to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem function, succession and long-term sustainability. Part of this process includes:

- Establishing a range of relevant reference sites to compare and track the progress and inherent ecosystem function of rehabilitation areas;
- Selecting a range of suitable reference sites that reflect the desired final land use, biodiversity targets and local community expectations; and
- Undertaking a monitoring program that provides simple but informative and reliable information that indicates positive recovery trends or rapid detection of rehabilitation failure.

Data obtained from within replicated reference woodland site were used to provide upper and lower ecological performance indicator limits. As not all key performance indicators are considered to be fundamental to completion, or in some cases achievable, key performance indicators (KPIs) have been further separated into "*Completion performance indicators*" and "*Desirable performance indicators"*. Completion performance indicators are those chosen as completion criteria targets and rehabilitation sites should equal, exceed or show positive trends towards those attributes of the reference sites. When these completion performance indicators have been met, or trending in the right direction, the sites should therefore theoretically be eligible for closure sign off. The range values of each performance indicator are adapted annually to reflect seasonal conditions and disturbance events. The same five monitoring sites established in the EOA in 2010 were revisited.

The full process associated with establishing the completion criteria relevant to rehabilitated native ecosystems can be found in "Rehabilitation monitoring methodology & Determination of completion criteria" (DnA Environmental 2011). Vegetation monitoring has been undertaken during spring in all monitoring years in this year was undertaken from 15 – 19th October. The monitoring methodology was consistent with that used in 2010 (DnA Environmental 2011a) and the NPM annual rehabilitation

monitoring program (DnA Environmental 2010a, b, 2011b, 2012, 2013). The methodology used included a combination of Landscape Function Analyses (CSIRO Tongway & Hindley 1996), accredited soil analyses and various measurements of ecosystem diversity and habitat values based on and adapted from the Biometric methodology (Gibbons 2002, Gibbons *et al* 2008a, 2008b) and these have been described in more detail below.

3.1 Landscape Function Analyses

The LFA is a methodology used to assess key indicators of ecosystem function including landscape organisation and soil surface condition as measure of how well the landscape retains and uses vital resources. It was developed by CSIRO scientists Tongway and Hindley (Tongway 1994, Tongway and Hindley 1995, 1996, 2003, 2004). The indicators used quantify the utilisation of the vital landscape resources of water, topsoil, organic matter and perennial vegetation in space and time.

The LFA methodology collects data at two "nested" spatial scales.

1. At coarse scale, **landscape organisation** is characterised. Patches and interpatches, indicators of resource regulation, are mapped at the 0.5 to 100 m scale from a gradient-oriented transect (making sense of landscape heterogeneity); and
2. At fine scale, **soil surface assessment** (soil "quality") examines the status of surface processes at about the 1-m scale, with rapidly assessed indicators on the patches and interpatches identified at coarse scale.

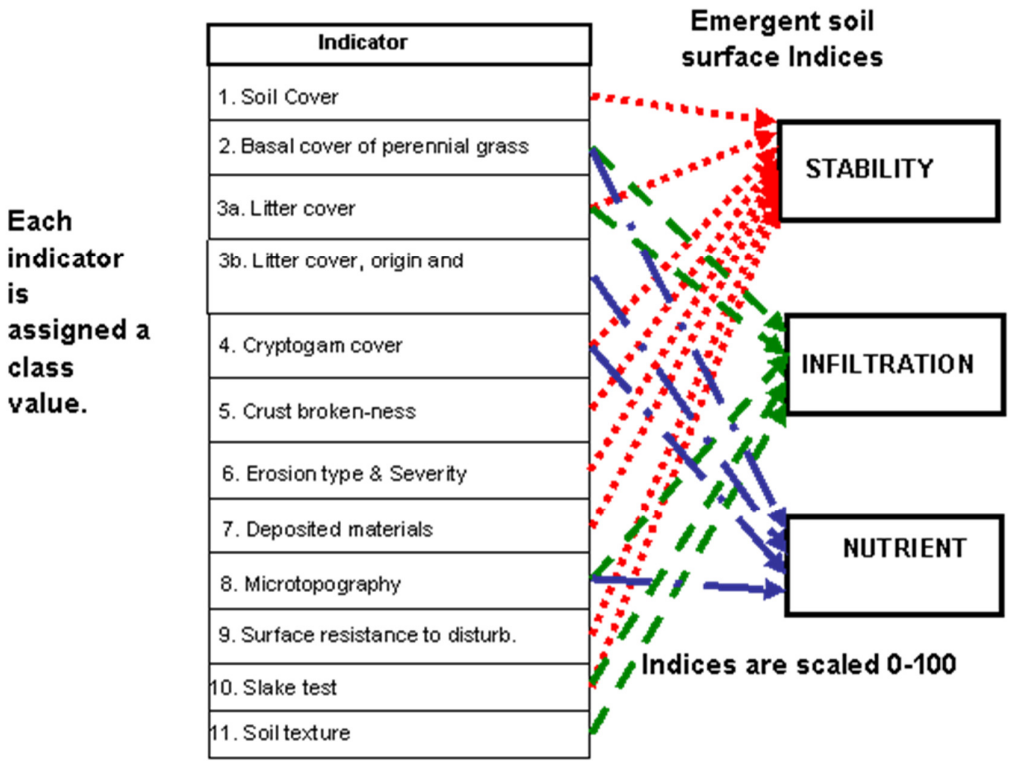
At each scale, parameters are calculated that reflect several aspects of landscape function. In the first stage, we identify and record the patches and interpatches along a line oriented directly down slope. Sometimes there are several different types of each patch/interpatch which provides a measure of heterogeneity or "**landscape organisation**".

In the second stage, called "**soil surface condition" (SSC)** assessment, it is possible to assess and monitor soil quality using simple indicators including:

- Rain splash protection;
- Perennial vegetation cover;
- Litter;
    - Percent litter cover;
    - Origin of the litter;
    - Extent of decomposition;
- Cryptogam cover;
- Crust Brokenness;
- Soil Erosion Type and Severity;
- Deposited Materials;
- Soil Surface Roughness;
- Surface Nature (resistance to disturbance);
- Slake Test; and
- Soil Surface Texture.

These 11 features are compiled and calculated into three indices of soil quality:

1. **Stability** (that is, resistance to accelerated erosion),
2. **Infiltration** (the rate soil absorbs water) and
3. **Nutrient Cycling** (the way plant litter and roots decompose and become available for use by other plants).



3.2 Soil analyses

Soil samples are undertaken using standard soil sampling techniques within the monitoring quadrat. At least 12 samples are taken at each site and bulked together. Soil samples are sent to Southern Cross University at their National Association of Testing Authorities (NATA) accredited laboratory for analysis. Soil analysis consist of assessing the parameters, pH, Electrical Conductivity (EC), Available Calcium (Ca), Magnesium (Mg), Potassium (K), Nitrate Nitrogen (N), Sulphur (S), organic matter (OM), exchangeable Sodium (Na), Ca, Mg, K, Hydrogen (H), cation exchange capacity, available and extractable Phosphorus (P), micronutrients (Zinc (Zn), Manganese (Mn), Iron (Fe), Copper (Cu), Boron (B), Silicon (Si), Aluminium (Al), Molybdenum (Mo), Cobalt (Co) and Selenium (Se)) and Total Carbon. The heavy metals including Cadmium (Cd), Lead (Pb), Arsenic (As), Chromium (Cr), Nickel (Ni), Mercury (Hg) and Silver (Ag) are also tested.

A report with analysis and desirable levels recommended in the agricultural industry is provided by the laboratory. Exchangeable Sodium Percentages were calculated as a measure of sodicity or dispersion.

3.3 Monitoring structural diversity, floristic and other biodiversity attributes

In addition to LFA, assessments of various biodiversity components must also be made to monitor changes in particular plants and groups of plants through the various successional phases and to document and/or identify critical changes or management actions required.

Some simple and rapid procedures for making these assessments were developed by CSIRO scientists (Gibbons 2002, Gibbons *et al* 2008), and were developed for assessment habitat quality across a range of vegetation types in the southern NSW Murray-Darling Basin. Some adaptations have been made to

reduce monitoring effort where possible, and to incorporate aspects of newly formed revegetation sites or sites in the early stages of recovery. For example some habitat features such as the detailed measuring and assessment of decomposition of the logs and branches has been omitted, whilst the understorey assessment included planted tubestock, direct seeding as well as natural recruitment and naturally occurring shrubs.

The rapid ecological assessment provides quantitative data that measures changes in:

- Floristic diversity including species area curves and growth forms;
- Ground cover diversity and abundance;
- Vegetation structure and habitat characteristics (including ground cover, cryptogams, logs, rocks, litter, projected foliage cover at various height increments);
- Understorey density and growth (including established shrubs, direct seeding and tubestock plantings and tree regeneration);
- Overstorey characteristics including tree density, health and survival; and
- Other habitat attributes such as the presence of hollows, mistletoe and the production of buds, flowers and fruit.

Permanent transects and photo-points are established to record changes in these attributes over time.

4 Reference sites

Despite 42 ha of the Estcourt site being derived native grassland, the VMP and VCA specify that these grassland areas are to be revegetated back to the original Eucalyptus *microcarpa* (Inland Grey Box) - *E. populnea* (Bimble Box) - *Callitris glaucophylla* (White Cypress Pine) tall woodland community (GHD 2010). Subsequently all five of the Estcourt monitoring sites were compared to woodland reference sites to assess the changes occurring within the existing woodland and active revegetation areas.

Four woodland communities have been identified across the NPM and surrounding properties (NPM 2008) and include:

- Tall *Eucalyptus microcarpa (*Grey Box) Open Woodlands;
- Mid – High/Tall *Callitris glaucophylla* (White Cypress Pine) – *Eucalyptus populnea* (Poplar Box) open woodland to savannah grassland;
- Mid – High/Tall *Eucalyptus populnea* (Poplar Box) open woodland to woodland; and
- Mid – High/Tall *Eucalyptus albens* (White Box) – *Callitris glaucophylla* (White Cypress Pine) woodland.

These communities are typical of the Parkes-Goonumbla area and occur within the majority of agricultural properties, roadside corridors and in the local Travelling Stock Routes of the area. The communities are generally confined to scattered remnants within agricultural areas while the forested areas in the bioregion include conservation reserves containing, larger, less disturbed remnants, some of which are floristically similar to the vegetation communities' onsite (NPM 2008).

The remnant vegetation on NPM property is generally in a poor condition and is considered to have a low conservation value (NPM 2008). In areas onsite where a native overstorey remains, the understorey is primarily dominated by introduced species. A few small areas have more than 50% native understorey however these are isolated and patchy within the general landscape of a highly modified and weed infested assemblage (NPM 2008). Remnants located on the adjacent Travelling Stock Routes are generally in better condition due to the different management practices and reduced grazing pressure.

These major vegetation communities have a patchy distribution across the local area and vary according to soil type and topography and often form ecotones. Species commonly associated with

these communities include *Alectryon oleifolius* (Rosewood), *Allocasuarina luehmannii* (Bulloak), *Brachychiton populneus* (Kurrajong) and *Geijera parviflora* (Wilga). On the heavier soils, subjected to inundation, *Acacia pendula* (Weeping Myall) and *Casuarina cristata* (Belah) can also be common. There are also areas dominated by *Eucalyptus melliodora* (Yellow Box) woodland and native grasslands (or derived native grasslands).

The composition and structure of the shrubby understorey is also variable but native shrubs including *Acacia decora* (Western Golden Wattle), *A. hakeoides* (Hakea Wattle), *Dodonaea viscosa subsp. cuneata* (Wedge-leaf Hopbush) and *Senna artemisoides* (Silver Cassia) are commonly encountered. The ground cover was often dominated by *Austrostipa* (Spear grasses) and *Austrodanthonia* species (Wallaby Grasses) with a scattering of native herbs such as *Vittadinia* (Fuzzweeds) and *Calotis* (Burr Daisies) and chenopod sub-shrubs including *Sclerolaena diacantha* (Grey Copperburr), *Atriplex spinibractea* (Spiny-fruit saltbush) and *Enchylaena tomentosa* (Ruby Saltbush). There were numerous patches of bare ground but leaf litter was a dominant form of ground cover in most sites.

All reference sites have been subjected to some form of disturbance, in particular clearing, logging and grazing and some sites were likely to be older regrowth. Exotic annual grasses and agricultural weeds such as *Carthamus lanatus* (Saffron Thistle), *Echium plantagineum* (Paterson's Curse) and *Sisymbrium orientale* (Hedge Mustard) were also common. These sites however are typical of the local area and will help set realistic rehabilitation targets and set a benchmark of the transitional processes that can be expected or that are presently occurring in the rehabilitation areas.

To account for variations in ecosystems across the landscape, we selected four woodland reference sites as examples of these woodland communities to allow for these inherent variations, range of local conditions and ecological transition. The reference sites selected were in close proximity to the NPM mine and the Estcourt Offset Area but were spread out where possible to maximize their spatial distribution. Different compositions of the dominant species of each reference site types were also targeted where possible. These reference sites were established in 2009 and are used as a point reference for rehabilitation sites which are monitored as part of the NPM annual rehabilitation program.

5 Rainfall

Total annual rainfalls recorded at the NPM compared to the long-term annual averages recorded at the Parkes Airport are shown in Figure 5-1. It should be noted that rainfall data for 2009 – 2011 was obtained from NPM weather station, however due to instrument failure rainfall data for 2012 was incomplete. For reliability rainfall data for Parkes Airport was used this year and direct comparison between data should be made with some discretion.

In 2009 the total rainfall was 250mm below average and with only 364mm was a particularly dry year and during the monitoring period the weather was very hot (>40°C) and windy with dust storms being a frequent occurrence. Subsequently there was little active plant growth and species diversity was very low. In contrast, 2010 had a total rainfall of 1026mm with most months providing above average growing conditions and the temperatures were milder. Extreme rainfall events were experienced in February and December (Figure 5-2) causing flooding across many parts of eastern Australia, including the local NPM area. The substantial increase in rainfall in 2010 resulted in significant changes occurring within the vegetation, in particular increases in total ground cover and species diversity and abundance across the range of sites.

Rainfall in 2011 continued to be above the long-term average with 676mm recorded, however 36% of this was experience after the monitoring period in November and December and the above average rainfall was experienced into March 2012, again producing widespread floods. Since then the conditions have become very dry with below average monthly rainfall falling throughout most of the year

with the exception of the 66.8mm which fell during July. August to October was very dry and in these months rainfall is particularly important for germination and establishment for many plants, especially annual species as the temperatures increase. Subsequently the drier conditions in the latter part of this year continues to influence the diversity, abundance and composition of the monitoring sites.

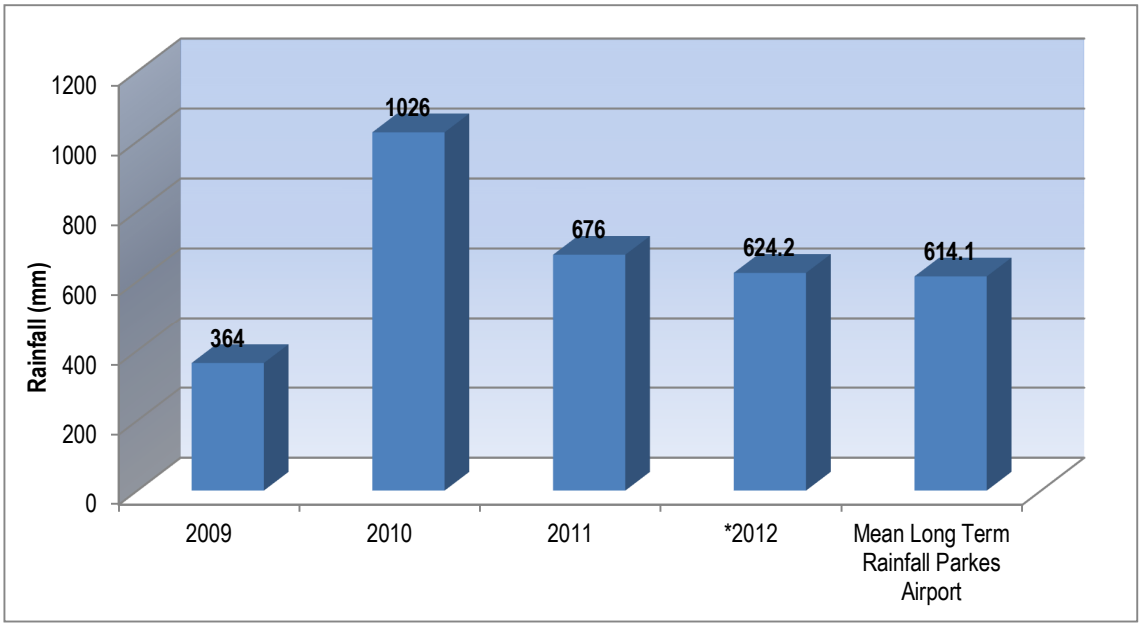


Figure 5-1. Annual rainfall recorded at NPM 2009-2012 compared to long-term mean annual rainfall for Parkes Airport AWS. (NB: All 2012 rainfall data from Parkes Airport AWS) *Jan-Nov 2012 only

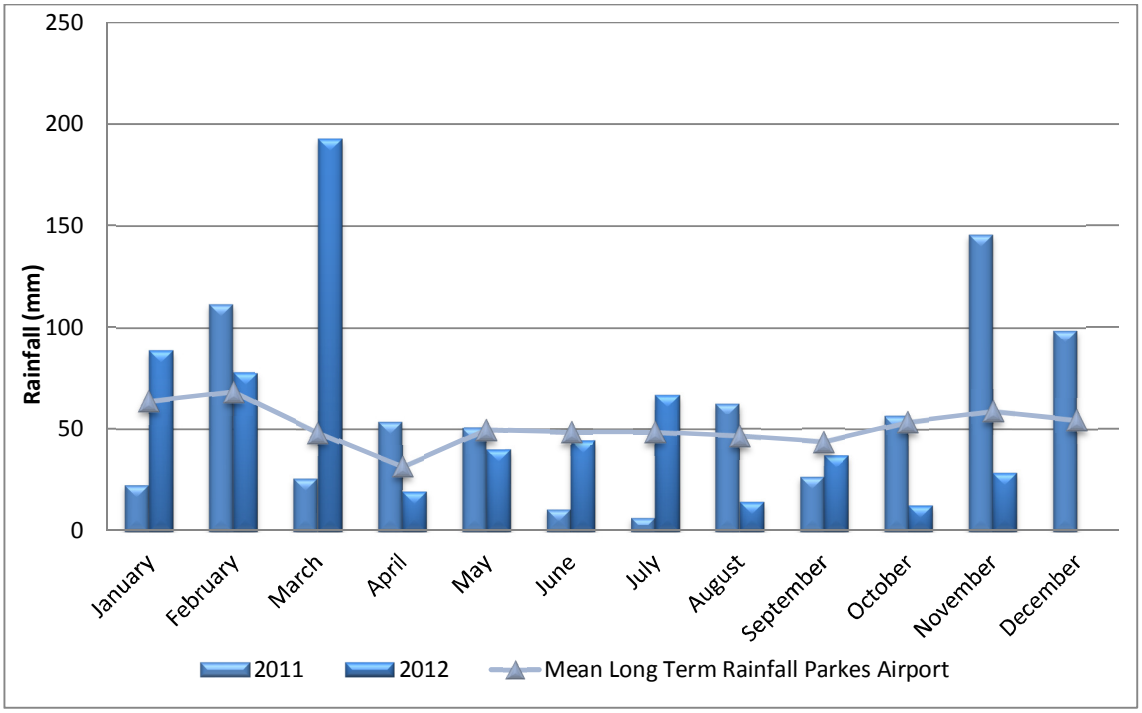


Figure 5-2. Monthly rainfall recorded at the Northparkes Mines from January 2011 to November 2012 compared to the long term monthly averages recorded at Parkes Airport AWS. (Nb:all 2012 rainfall data from Parkes Airport AWS)

6 General site descriptions and permanent photo-points

6.1 Reference sites

The location of the woodland reference sites in relation to the Estcourt Offset Area is shown in Figure 6-1. General descriptions of the reference sites, including photographs taken in the permanent monitoring quadrats along the vegetation transect in 2009 – 2012 have been provided in Table 6-1. GPS coordinates and other site specific information is provided in Table 6-2.

Figure 6-1. Map showing the location of the Woodland reference sites in relation to the Estcourt Offset Area (Image: Google Earth Pro 2010).

Table 6-1. General site descriptions and permanent photo-points of the reference monitoring sites.

Site	Photo 2009	Photo 2010	Photo 2011	Photo 2012
RWood01	An open grassy woodland dominated *by E. microcarpa* with some *Allocasuarina luehmannii* and *Alectryon oleifolius* sub dominants. Situated approximately 5km north of the NPM access Rd on the left side of the Bogan road on the TSR. There were some large old regrowth trees, scattered regrowth and some limited regeneration of the overstorey species. The site had small scattered patches of *Dodonaea viscosa* subsp. *cuneata, Acacia hakeoides* and *Maireana microphylla*. The ground cover contained sparsely scattered tussocks of *Austrostipa* and *Austrodanthonia* species as well as a variety of small chenopod sub-shrubs. In 2009 the wildflowers were flowering. Leaf litter was abundant beneath tree canopies but there were numerous patches of bare ground particularly in the more open areas, which were commonly covered with cryptogams. There were some fallen branches. In 2010, the area had been recently grazed by travelling stock with some shrubs damaged and some grass tussocks had been pulled out. In 2011, there was no evidence of recent livestock grazing however there was less plant diversity due to the drier conditions. In 2011 the *Austrostipas* were flowering and one large *E. microcarpa* had fallen down. In 2012 the site continued to be very dry.			
				
RWood02	An open regrowth woodland dominated *by E. albens, E. populnea and Callitris glaucophylla* with some older *Callitris* and eucalypt regeneration. This site was located on the hill near "Berra Lee" on the Bogan Rd, east of the NPM. The site had small scattered patches of *Acacia deanei* with some limited regeneration of the overstorey species. The ground cover contained sparsely scattered tussocks of *Bothriochloa macra*, *Austrostipa* and *Austrodanthonia* species as well as a diverse range of herbs and forbs which were flowering. Leaf litter was abundant beneath tree canopies but there were numerous patches of bare ground particularly in the more open areas, which were commonly covered in cryptogams. There were some fallen branches and an active presence of ants and ant nests. In 2010, the area had been recently grazed by travelling stock with numerous deep hoofprint depressions scattered across the site, but there was little grazing damage. In 2011, there was no evidence of recent livestock grazing however there was less plant diversity due to increased grass cover and drier conditions. In 2012 the site continued to be very dry.			
				

Site	Photo 2009	Photo 2010	Photo 2011	Photo 2012
RWood03	An open grassy woodland dominated *by E. microcarpa* with an individual *Allocasuarina luehmannii*. The site is situated east of the Tailings Storage Facility (TSF) 1 on the left side of the Bogan road on the TSR. There were some large old growth trees with hollows, scattered regrowth and some limited regeneration of the overstorey species. The site had small scattered patches of *Dodonaea viscosa* subsp. *cuneata, Acacia hakeoides* and *Senna artemisoides*. The ground cover contained sparsely scattered tussocks of *Austrostipa* and *Austrodanthonia* species as well as a variety of small chenopod sub-shrubs. Leaf litter was abundant beneath tree canopies but there were numerous patches of bare ground particularly in the more open areas, which were commonly covered in cryptogams. There were some fallen branches. Grey Crowned Babblers were present at this site. In 2010, the area had been recently grazed by travelling stock with numerous deep hoofprint depressions scattered across the site, but there was little grazing damage. In 2011, there was no evidence of recent livestock grazing however there was less plant diversity due to increased grass cover and drier conditions. In 2012 the site continued to be very dry.			
				
RWood04	An open woodland dominated *by E. populnea, E. melliodora* and *Callitris glaucophylla* which has some large old growth trees and numerous stumps, evidence of past logging. This site was located in the Limestone State Forest within the NPM mining lease. No shrubs or tree regeneration were recorded. The ground cover was patchy and contained sparsely scattered tussocks of *Austrostipa* and *Austrodanthonia* species. In 2009 there was a limited diversity of herbs and forbs, but generally total ground cover was good with large patches of *Xerochrysum bracteatum* (Golden everlasting) scattered across the forest area. In 2010, there was a high diversity of native understorey species, including significant patches of *Dicopogon* (Chocolate lily). There were also old stock camps beneath the trees which were dominated by weeds. The area is not subjected to livestock grazing but maintains a healthy macropod population. In 2011, there had been a significant increase in grass cover resulting in lower plant diversity and fewer weeds, especially beneath the tree canopies in the old stockcamps. The patch of *Dichopogon* was reduced to about one dozen individuals due to increased competition and drier conditions. In 2012 the site continued to be exceptionally dry but there was some Callitris regeneration.			
				

Table 6-2. GPS co-ordinates, aspects and slopes of the woodland reference sites.

Site Reference	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing °
RWood01	55599368 E 6361978 N	55599386 E 6361982 N	0	52 NE	55599378 E 6361978 N	55599399 E 6361934 N	142 SE
RWood02	55604368 E 6350055N	55604386 E 6350060 N	5	56 NE	55604378 E 6350058 N	55604394 E 6350012 N	158 SE
RWood03	55600792 E 6359342 N	55600772 E 6359350 N	1	269 W	55600781 E 6359348 N	55600794 E 6359393 N	0 N
RWood04	55597396 E 6356649 N	55597398 E 6356626 N	4	159 S	55597398 E 6356637 N	55597350 E 6356628 N	240 SW

6.2 Revegetation monitoring sites

The monitoring sites were chosen to capture changes occurring within the different community types or "zones" and their associated restoration activities. Subsequently five sites were established with two of these occurring within the derived grassland area destined for replanting to re-establish the original grassy woodland community. Three sites occurred in the existing woodland areas (zone two), whereby one site is situated in a grassy clearing (sub-zone 2b) and will require supplementary planting with the remaining two sites situated within open woodland areas where natural regeneration will be anticipated, and some supplementary hand planting will be undertaken (GHD 2010).

The location of the revegetation monitoring sites in the Estcourt Offset Area is shown in Figure 6-2. General site descriptions including photographs taken during 2010 – 2012 are provided in Table 6-3. The site coordinates and other details are given in Table 6-4.

6.3 Additional photo points

As part of the VMP, GHD established seven photo points within the Estcourt Offset Area in 2009. These sites were also revisited 2010 - 2012 by DnA Environmental and the results have been provided in Table 6-5.

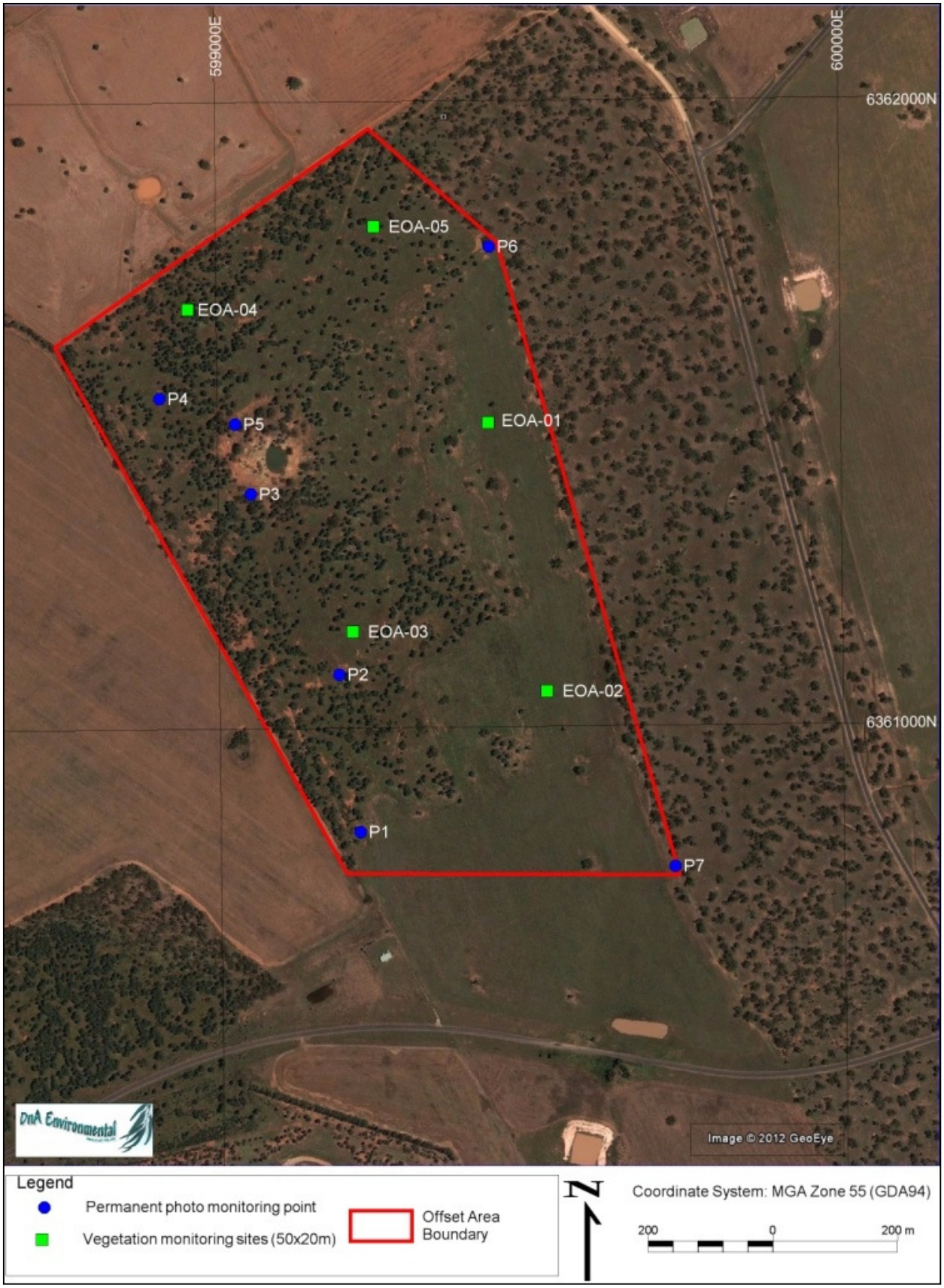
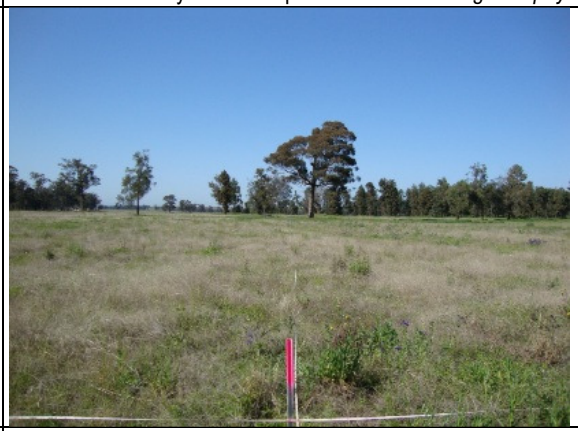
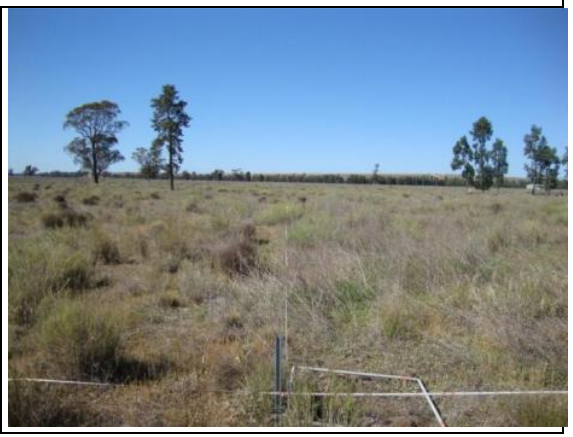
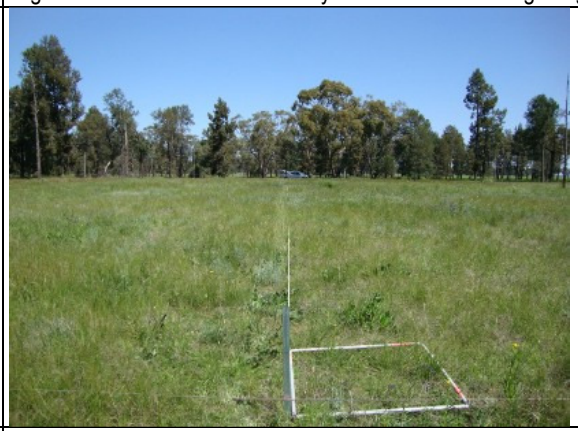


Figure 6-2. Map showing the locations of the vegetation monitoring sites and permanent photo points within the Estcourt Offset area (Image: Google Earth Pro 2010).

Table 6-3. General site description of the EOA monitoring sites.

Site	Photo 2010	Photo 2011	Photo 2012
EOA-01	A derived grassland situated to the northeast of the Estcourt Offset Area. The site was an old cropping paddock that has not been recently grazed. In 2010 it contained a diverse understorey of native and introduced species including *Dicondra repens*, *Hordeum leporinum*, *Chloris truncata* and *Medicago polymorpha*. There was high in floristic diversity (57 species) and native species (34) were more abundant than exotic species (23). There was good ground cover and cryptogams were moderately abundant. There were scattered occurrences of *Echium plantagineum, Arctotheca calendula, Centaurea melitensis* and *Sonchus oleraceus*. In 2011, there were increased levels of ground over, decreased abundance of cryptogams and increased diversity of exotic species. One *Callitris glaucophylla* seedling was found. In 2012 the site was similar to but drier than last year and seven *C. glaucophylla* seedlings were found.		
			
EOA-02	A derived grassland situated to the southeast of the Estcourt Offset Area. The site was an old cropping paddock that had not been recently grazed. In 2010 it contained a diverse understorey of native and introduced species including *Dicondra repens*, *Eragrostis parviflora* and *Medicago polymorpha*. There was a relatively high floristic diversity (48 species) and native species (26) were more abundant than exotic species (22). There was generally good ground cover and cryptogams were moderately abundant in the southern end of the transect. There were scattered occurrences of *Carthamus lanatus, Echium plantagineum* and *Arctotheca calendula*. In 2011, it was similar to EOA-01 with increased levels of ground over, decreased abundance of cryptogams but maintained a high diversity of native and exotic species and weeds were less abundant. In 2012 the site was similar to but drier than last year and 24 *C. glaucophylla* seedlings were found.		
			

Site	Photo 2010	Photo 2011	Photo 2012
EOA-03	An open grassy clearing situated in the centre of the southern woodland area on top of the hill. It was dominated by native grasses particularly *Austrostipa scabra subsp. falcata* and contained a very high diversity of native (43) and introduced species (18) including many Asteraceae and Poaceae species. There was good ground cover provided by perennial plants. There were sparse occurrences of *Carthamus lanatus, Echium plantagineum, Salvia verbenaca, Erodium cicutarium* and a variety of *Medicago* and *Trifolium species.* On the fringing woodland (photo point 2 GHD 2010), there was a diverse range of additional native species including *Arthropodium minus, Stackhousia monogyna, Pterostylis sp, Dicopogon stricta, Bulbine bulbosa, Goodenia pinnatifida* and *Calotis cuneifolia* to name a few. In 2011 and 202 the site was very dry with macropod grazing maintaining low grass cover. There was a significant decline in floral diversity but the site retained good ground cover. In 2012 seven *C. glaucophylla* seedlings were found.		
			
EOA-04	Estcourt Offset Area 04 (EOA-04) was situated on the edge of a woodland stand to the west of the site which contained a moderate canopy of *Callitris glaucophylla* trees of varying health, including numerous dead stags. The vegetation transect extended into an area of open grassland, which contained a higher diversity of native ground cover species than beneath the tree canopies. The understorey was relatively weedy with *Lolium* and *Trifolium* species being very common, but it retained high native species diversity (51 species) and native perennial grasses were particularly dominant. There were no shrubs and no tree hollows were observed. The site had very high species diversity (71 species). In 2011 and 2012 the drier seasonal conditions has resulted in a reduction in floristic diversity. In 2011 four regenerating *Dodonaea viscosa* subsp *cuneata* were recorded. In 2012, there were 7 *Dodonaea* and two *Callitris* seedlings.		
			

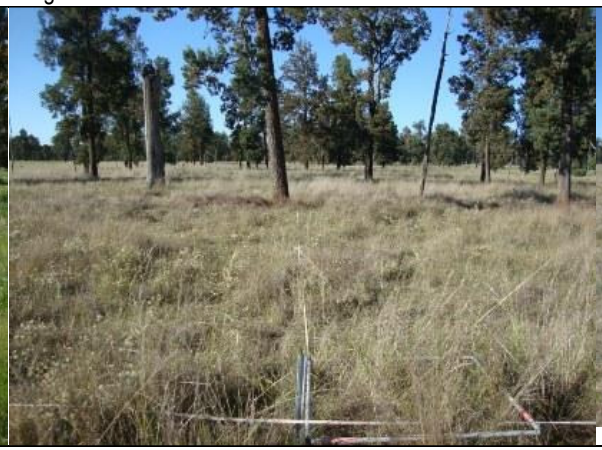
Site	Photo 2010	Photo 2011	Photo 2012
EOA-05	Estcourt Offset Area 05 (EOA-05) was situated to the north east of the site within a sparse woodland stand of *Callitris glaucophylla* trees, including two dead stags. There was no *C. glaucophylla* recruitment but the trees were flowering or contained fruit. The understorey was relatively weedy (23 exotic species) especially beneath the trees where there were remnant stockcamps, with *Lolium* and *Trifolium* species being very common, but it retained high native species diversity (49 species) and native perennial grasses were particularly dominant. There were no shrubs and one tree hollow was observed in one of the dead stags. The site had very high species diversity (72 species). In 2011, later monitoring and drier seasonal conditions has resulted in a reduction in floristic diversity. In 2012 the site was very dry with macropod grazing maintaining low grass cover. There was a significant decline in floral diversity but the site retained good ground cover. In 2012 11 *C. glaucophylla* seedlings were found.		
			

Table 6-4. GPS co-ordinates, aspects and slopes of the offset monitoring sites (GDA94).

Site Reference	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing°
EOA-01	55 599435E 6361486N	55 599455E 6361488N	1	78 E	55 599447E 6361487N	55 599450E 6361440N	170 S
EOA-02	55 599526E 6361056N	55 599551E 6361055N	1	83 E	55 599539E 6361055N	55 599541E 6361010N	175 S
EOA-03	55 599215E 6361154N	55 599229E 6361139N	0	119 SE	55 599226E 6361145N	55 599188E 6361111N	212 SW
EOA-04	55 598954E 6361670N	55 598968E 6361674N	1	41 NE	55 598961E 6361672N	55 598991E 6361635N	132 SE
EOA-05	55 599254E 6361808N	55 599276E 6361785N	1	92 E	55 599269E 6361791N	55 599256E 6361743N	183 S

Table 6-5. Permanent Photo Points within the offset area

Photo point/ Coordinates	2010 Photo	2011 Photo	2012 Photo
P1 55 599223E 6360833N			
P2 55 599191E 6361085N			
P3 55 599052E 6361375N			

Photo point/ Coordinates	2010 Photo	2011 Photo	2012 Photo
P4 55 598907E 6361528N			
P5 55 599028E 6361486N			
P6 55 599438E 6361766N			

Photo point/ Coordinates	2010 Photo	2011 Photo	2012 Photo
P7 55 599728E 63607758N			

7 Summary of results recorded in the Estcourt Offset monitoring sites

The following section provides a summary of results from the five EOA rehabilitation sites compared to the woodland reference sites obtained during 2010 - 2012. Full descriptions of the individual sites are provided in Sections 10 to 14.

7.1 Landscape Function Analyses

7.1.1 Landscape Organisation

A patch is an area within an ecosystem where resources such as soil and litter tend to accumulate, while areas where resources are mobilised and transported away are referred to as interpatches. Landscape Organisation Indices (LOI) are calculated by the length of the patches divided by the length of the transect to provide an index or percent of the transect which is occupied by functional patch areas (Tongway and Hindley 2004).

All sites, including the five Estcourt rehabilitation sites continued to have a Landscape Organisation Index (LOI) of 100% (Figure 7-1) indicating that they were well vegetated and there was no leakage of resources within these sites.

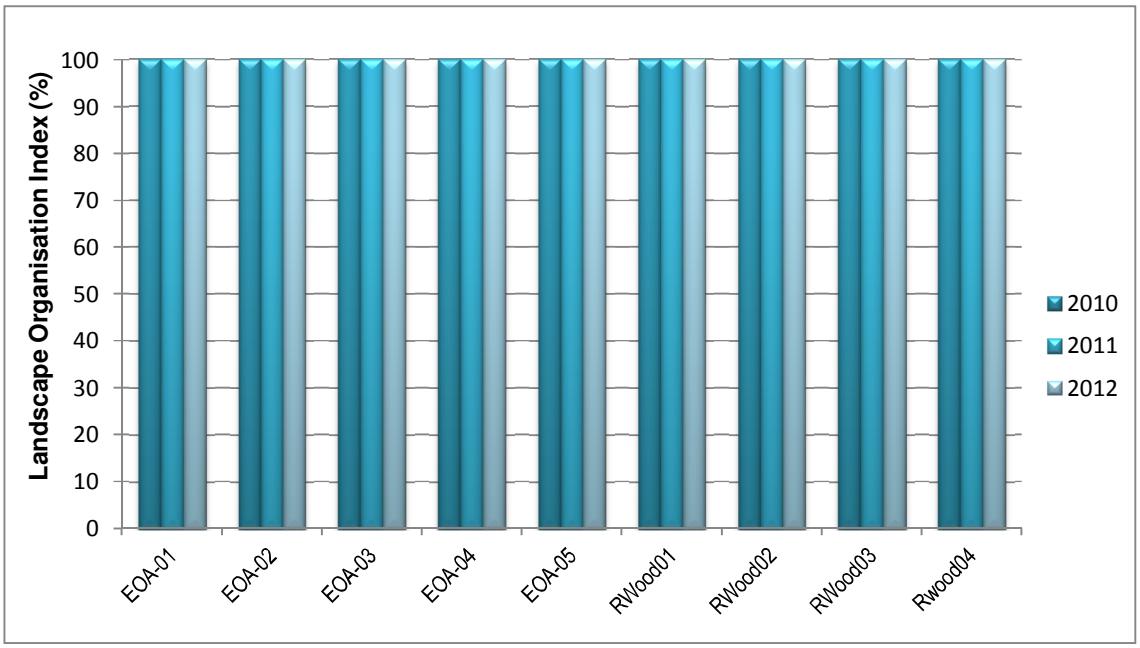


Figure 7-1. Landscape organisation indices recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 - 2012.

7.1.2 Soil surface assessments

7.1.2.1 Stability

Since 2011 the LFA stability indices of the revegetation sites have typically declined across all of the Estcourt revegetation sites but this trend was also evident within the woodland reference sites and was a reflection of the prolonged dry conditions and typically declining perennial vegetation cover.

Subsequently the LFA stability range was slightly lower this year and ranged from 63.5 – 71.0. However there continued to be high levels of ground cover maintained in all EOA sites and they all exceeded this stability target range this year (Figure 7-2). In the EOA monitoring sites the lowest stability index recorded was 73.0 in EOA-03, while the highest index of 75.5 was recorded in EOA01. The high stability in the EOA-01 and EOA-02 were largely due to the development of very hard soil crusts and they contained a higher abundance of cryptogam cover.

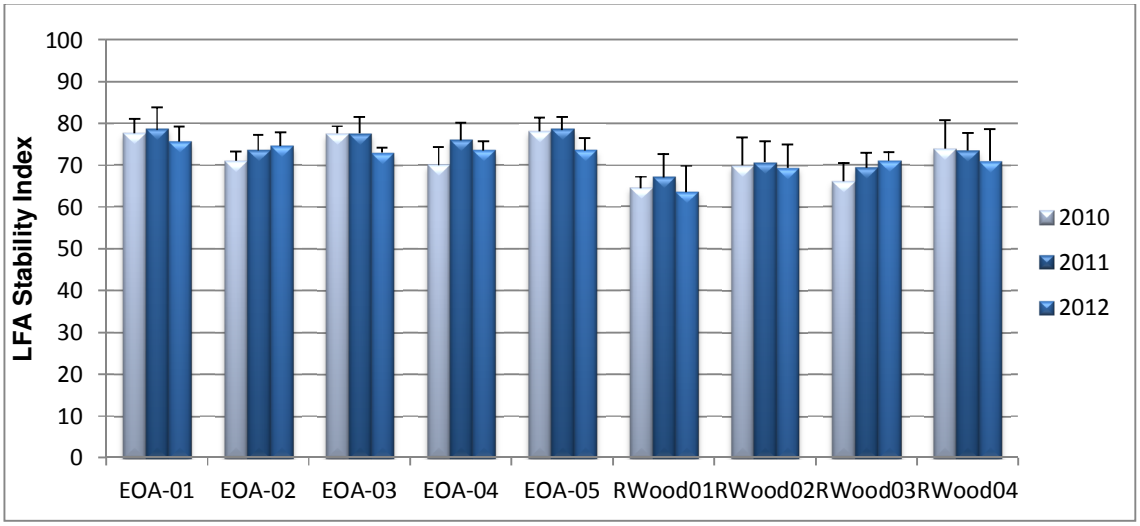


Figure 7-2. Comparison of LFA stability indices between the Estcourt Offset monitoring sites and the woodland reference sites 2010 - 2012.

7.1.2.2 Infiltration

While there was no consistent trend in changes in LFA infiltration indices within the monitoring sites typically they remained unchanged or were marginally lower than last year and this was also observed within all but one of the woodland reference sites which provided a marginally higher LFA infiltration range of 44.4 – 52.8 (Figure 7-3). This year the recovering grassland areas had a lower infiltration capacity and did not meet the required LFA targets largely due to the development of very hard soil crusts and they had a lower abundance of cryptogams. The remaining EOA sites continued to fall within the target range. In the EOA monitoring sites the lowest infiltration index recorded was 40.7 in EOA-02, while the highest index of 52.7 was recorded in EOA-04.

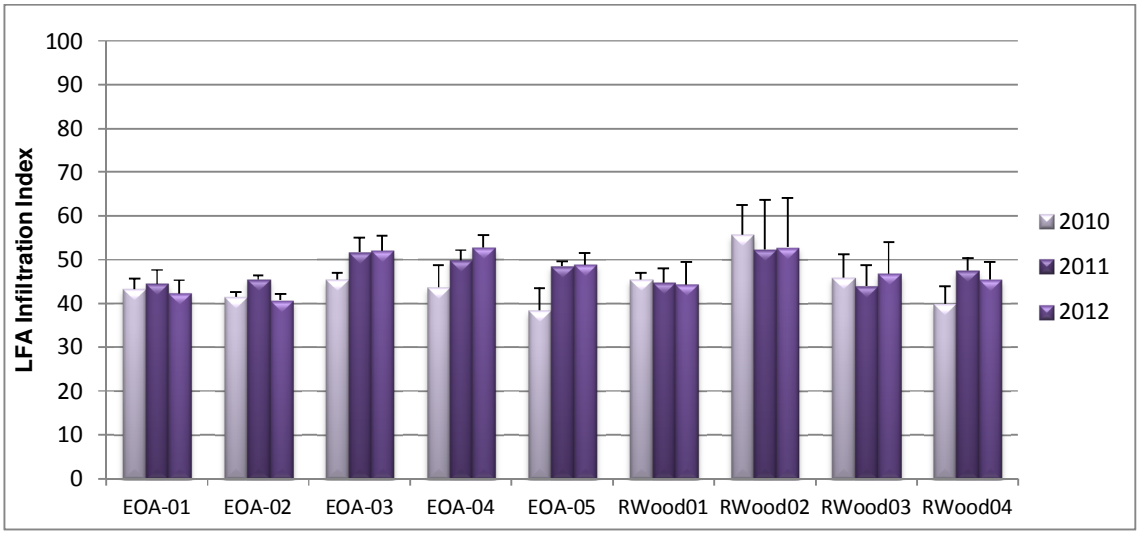


Figure 7-3. Comparison of LFA infiltration indices between the Estcourt Offset monitoring sites and the woodland reference sites 2010 - 2012.

7.1.2.3 Nutrient recycling

Similarly there was also no consistent trend in changes in LFA nutrient recycling indices within the monitoring sites with some sites demonstrating a small but increasing trend and this was largely due to the accumulation of dead leaf litter and increasing states of litter decomposition, indicating increased levels of microbial and fungal activity. While this was commonly observed across numerous sites, the decline in perennial plant and cryptogam cover and across most sites may have resulted in no net changes. In the woodland reference sites nutrient recycling indices ranged from 40.9 – 51.6 and all EOA sites fell within this range (Figure 7-4). In the EOA monitoring sites the lowest nutrient recycling index recorded was 42.3 in EOA-02, while the highest index of 49.6 was recorded in EOA-04.

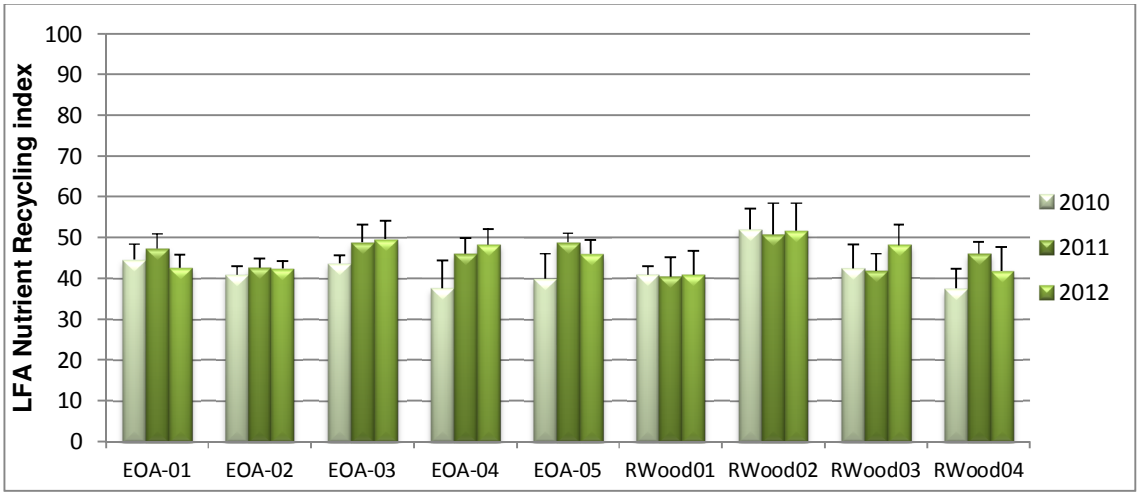


Figure 7-4. Comparison of LFA nutrient recycling indices between the Estcourt Offset monitoring sites and the woodland reference sites 2010 - 2012.

7.1.2.4 LFA Summary

Most changes in stability, infiltration and nutrient recycling were largely due to a decrease in perennial plant cover and increased cover and depth of litter combined with increased rates of litter decomposition. The high levels of ground cover have also limited the extent of erosion despite the high rainfall activity over summer, however high levels of ground cover have tended to result in a general decline in abundance of cryptogams. The increasing states of decomposition of the litter layer indicate higher levels of microbial and fungal activity and these are assisting in the development of a humus layer. Increasing levels of humus can reduce soil surface crusting and hardness and this was becoming more evident in several sites.

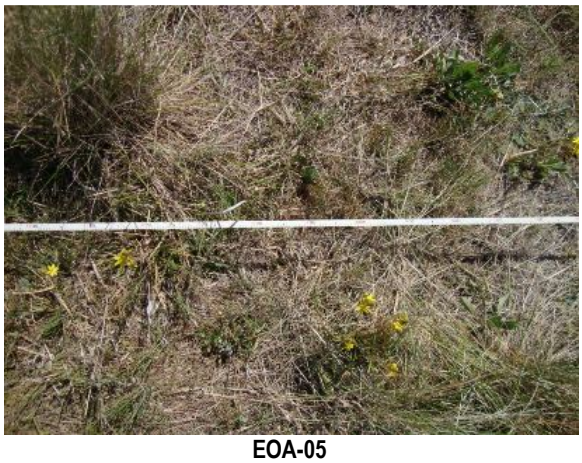
These data indicate the least disturbed EOA sites (EOA-03, EOA-04 and EOA-05) sites were ecologically functional communities and were comparable or similar to the local woodland reference communities. The recovering grassland areas (EOA-01 and EOA-02) have been demonstrating positive successional trends but this year the prolonged dry conditions have caused a slight decline in the ecological function within these sites, but this was also demonstrated within some of the more established monitoring sites and some reference sites. Nonetheless, the recovering grasslands were more stable than and had a nutrient recycling capacity comparable to the local woodland communities. Examples of the various combinations of ground covers which are critical to overall ecosystem function have been provided in Table 7-1.

Table 7-1. Examples of the different ground covers in the woodland monitoring sites.

EOA-01

EOA-02

EOA-03



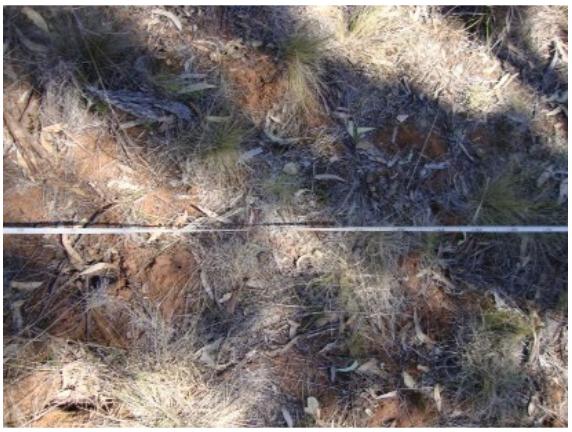
EOA-04

EOA-05

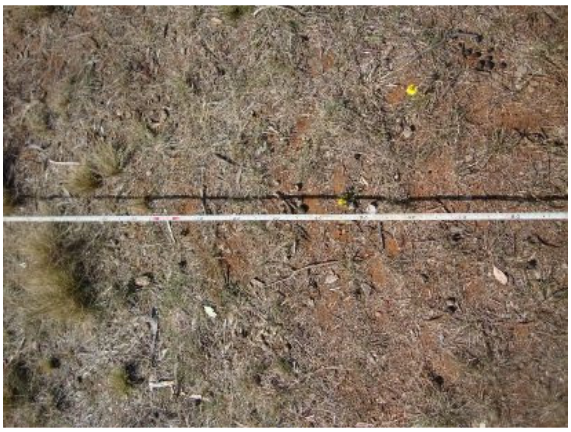
RWood01

RWood02

RWood03



RWood04



7.2 Tree density

Mature trees and shrubs with a stem diameter >5cm dbh continued to be recorded in all reference sites and there were two additions in RWood02 and one in RWood03 as the larger shrubs had continued to grow. This year in the 50 x 20m monitoring quadrat the target density range was 5 – 19 individuals which equates to a density of 50 - 190 stems per hectare.

There continued to be 14 trees recorded in EOA-04 and there were three in EOA-05. No trees or mature shrubs were yet present in the recovering grassland EOA-01 and EOA-02 sites or in the grassy clearing of EOA-03 (Figure 7-5). Common species of trees and mature shrubs recorded in the reference sites were *Allocasuarina luehmannii, Callitris glaucophylla, Eucalyptus albens, E. microcarpa, E. populnea* and *Acacia hakeoides.*

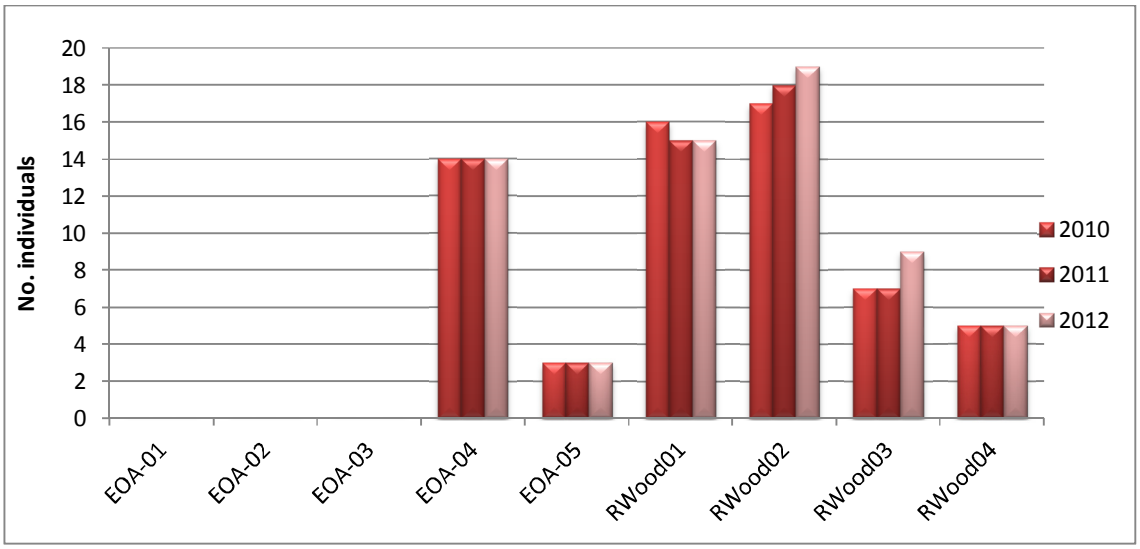


Figure 7-5. Tree densities (>5cm dbh) in the Estcourt Offset sites compared to the woodland reference sites 2010 - 2012.

7.3 Shrubs and juvenile trees

The number of shrubs and juvenile trees with a stem diameter <5cm dbh continued to be highly variable within the reference site and there has been an increase in number of individuals in all four sites as result of recruitment events probably initiated by the high rainfall activity which has occurred over the last two summer periods. While no shrubs were present in RWood04 last year, this year there were 48 small *Callitris glaucophylla* seedlings. The resultant target range therefore was significantly higher at 30 – 134 seedlings per 0.1ha. Young seedlings were also recorded in all EOA monitoring sites this year with the lowest density of seven being recorded in EOA-01 and EOA-03, while the highest density was recorded in EOA-02 with 24 individuals (Figure 7-6).

While in almost all EOA monitoring sites the seedlings were *Callitris glaucophylla*, eight *Dodonaea viscosa* subsp. *cuneata* were present in EOA-04. In the reference sites the most common shrubs included *Allocasuarina luehmannii, Eucalyptus microcarpa, Dodonaea viscosa subsp. cuneata, Senna artemisioides subsp filifolia* but there were some *Acacia hakeoides, Acacia deanei, Alectryon oleifolius* and *Eucalyptus albens* recorded in at least one reference site.

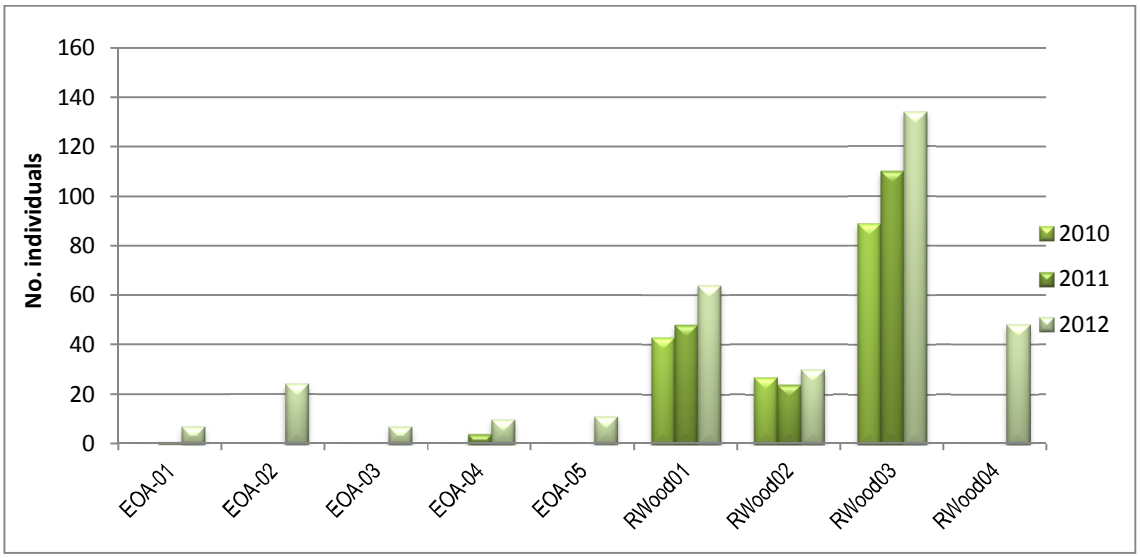


Figure 7-6. Total live shrubs recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 – 2012.

7.4 Total ground Cover

Total ground cover is derived from various combinations of dead leaf litter, annual and perennial plants and in some sites there were small contribution from cryptogams and logs. In 2010 grazing by the travelling stock within the reference sites left numerous hoof print depressions which had destroyed the protective cover across numerous sites. However due to the absence of grazing in 2011 and increased plant growth in these sites there was an increase in total ground cover in all reference sites, except RWood01. This year the prolonged dry conditions combined with some macropod grazing had caused a marginal decline in total ground cover in three of the four reference sites and a resultant target range of 86.5 – 98.5% (Figure 7-7). Total ground cover recorded in the EOA monitoring sites was negligibly lower or had remained at 100% and all revegetation sites at the Estcourt Offset Area and continued to exceed the target.

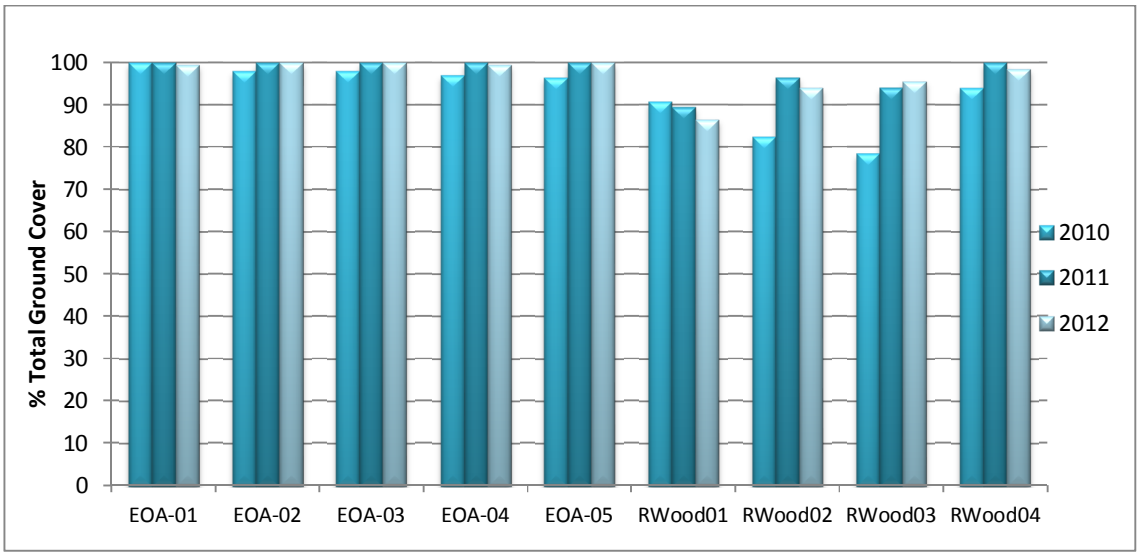


Figure 7-7. Total ground cover recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 - 2012.

7.5 Structural composition

The various combination of the ground cover and structural composition of the woodland sites are provided in Figure 7-8 which indicates the most dominant form of ground cover continued to be dead leaf litter which has increased since 2010 due to decline in perennial plant cover. Perennial grasses and forbs are also an important component in the woodland sites and while these provided relatively low cover values ranging from 9 – 35.5%, EOA-01 had only 7% perennial ground cover and did not meet this target.

Annual plants which were almost always exotic species also provided significant levels of ground cover within the two derived grassland areas as these were in the early recovery stages, but in the older more established sites annual plants were relatively insignificant and in EOA-04 and EOA-05 annual plants were not present along the vegetation transect. Cryptogams were present in low abundance in two of the reference sites but none were present in the EOA sites this year due to the increasing levels of dead litter covers. Fallen branches were common but provided only limited ground cover and rocks were not important habitat components in the grassy ecosystems.

The reference sites were characterised by having at least some mature canopy cover which exceeded 6.0m in height and in some there was foliage cover the was 4 - 6.0m in height but typically there was

limited projected foliage cover within the 0.5 -2.0 and 2.0 - 4.0m height increments. The structural composition of the woodland monitoring sites has been provided in Table 7-2.

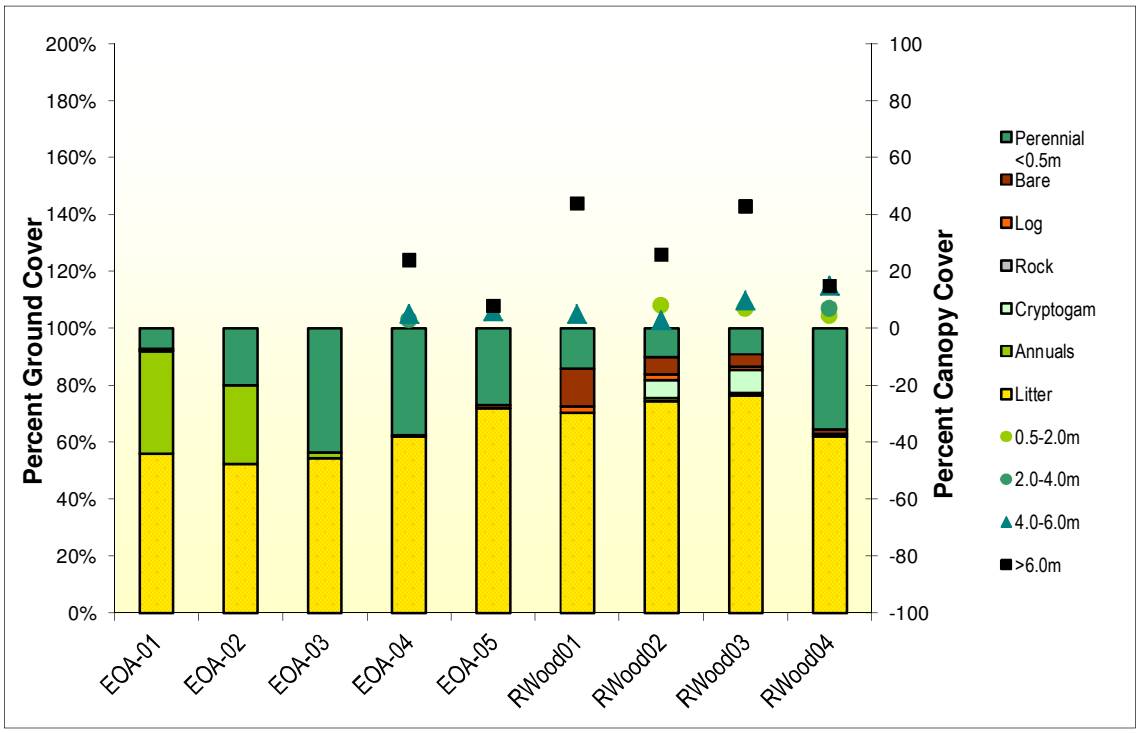
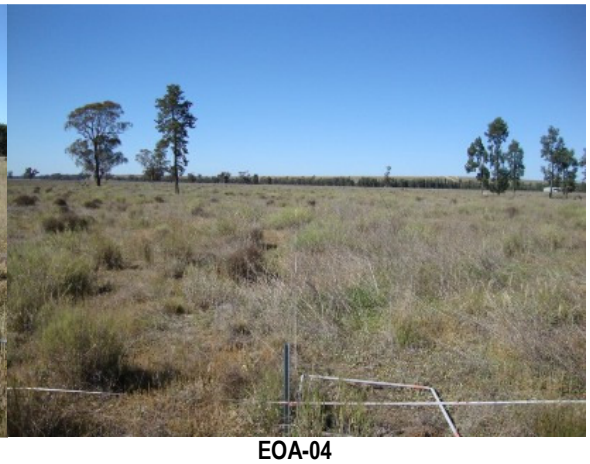


Figure 7-8. Average percent ground cover and projected foliage cover recorded in the woodland monitoring sites in 2012.

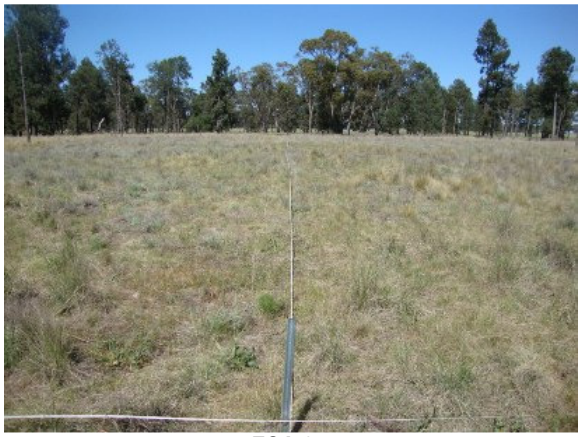
Table 7-2. The structural composition of the woodland monitoring sites.

EOA-01

EOA-02



EOA-03



EOA-04

EOA-05

RWood01

RWood02

RWood03

RWood04

7.6 Species Diversity

7.6.1 Total species diversity

Last year the later monitoring and drier seasonal conditions resulted in a significant reduction in floral diversity across all monitoring sites with the exception of EOA-01 which had one additional species and the woodland reference sites provided a total species target range of 41 - 55 compared to 53 – 71 recorded in 2010. In 2012 however there were no consistent trends in the changes in species diversity with some sites demonstrating increasing floristic diversity while some demonstrated declining species diversity but this variability was also observed within the reference sites.

There were 44 – 60 different species recorded in the reference sites this year, and all sites contained this or exceeded this floral diversity. Of the EOA monitoring sites lowest species diversity was recorded in EOA-02 which had 46 species and the highest was recorded in EOA-01 with 59 different species.

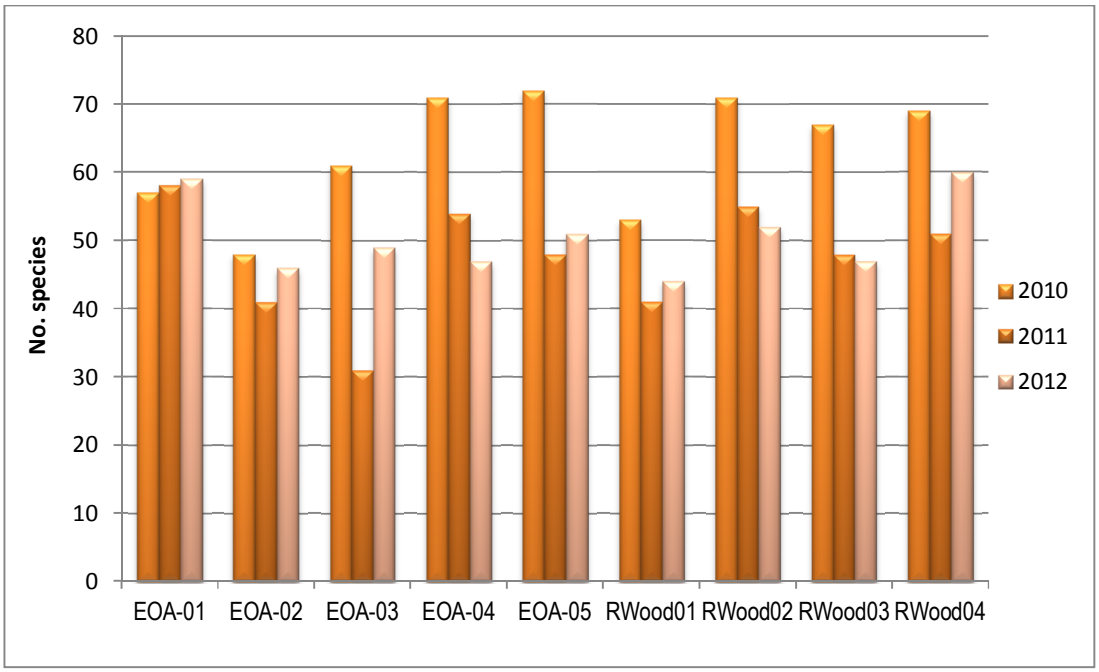


Figure 7-9. Total species diversity recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 – 2012.

7.6.2 Native species diversity

Last year there was also a reduction in native species richness across all sites and there were 31 – 44 native species in the reference sites compared to 53 – 71 recorded in 2010 (Figure 7-10). In 2012 however there were no consistent trends in the changes in native species diversity but typically there appeared to be an increase across most sites with the reference sites providing a target of 39 – 44 different native species. EOA-05 was the only site that contained this diversity of native species which was equivalent to the minimum target of 39 species. The remaining sites contained 27 (EOA-02) – 38 (EOA-04) native species.

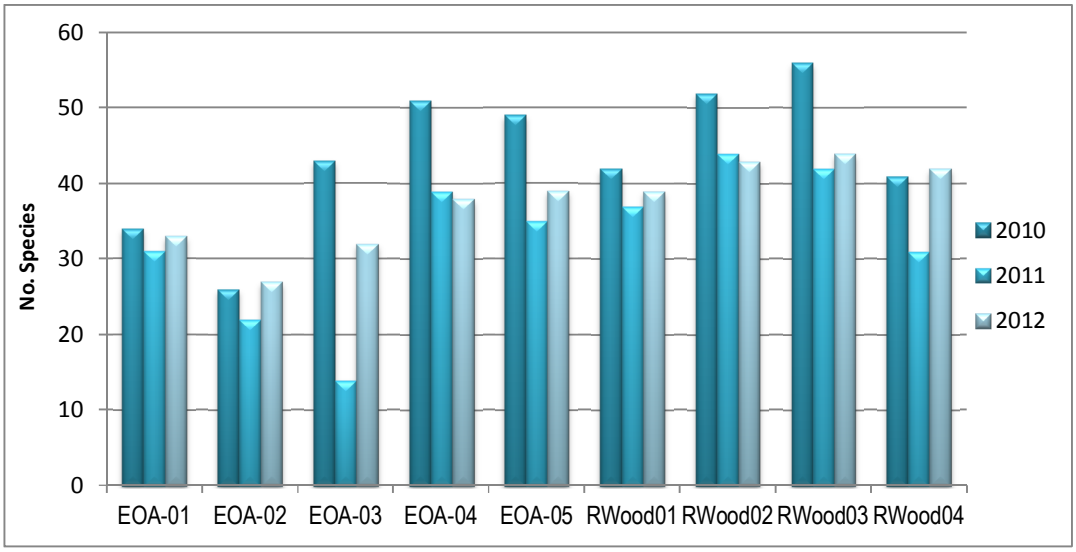


Figure 7-10. Total native species recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 – 2012.

7.6.3 Exotic species diversity

In most cases the number of exotic species has demonstrated a declining across almost all monitoring sites this year as many annual species had their short spring lifespan significantly shortened by the dry seasonal conditions. In the reference sites there were 3 – 18 exotics species, with RWood04 having been associated with an old stock camp (Figure 7-11). The older more established EOA sites contained an acceptable level of weeds but in the recovering grasslands EOA-01 and EOA-02 there were 27 and 19 exotic species respectively.

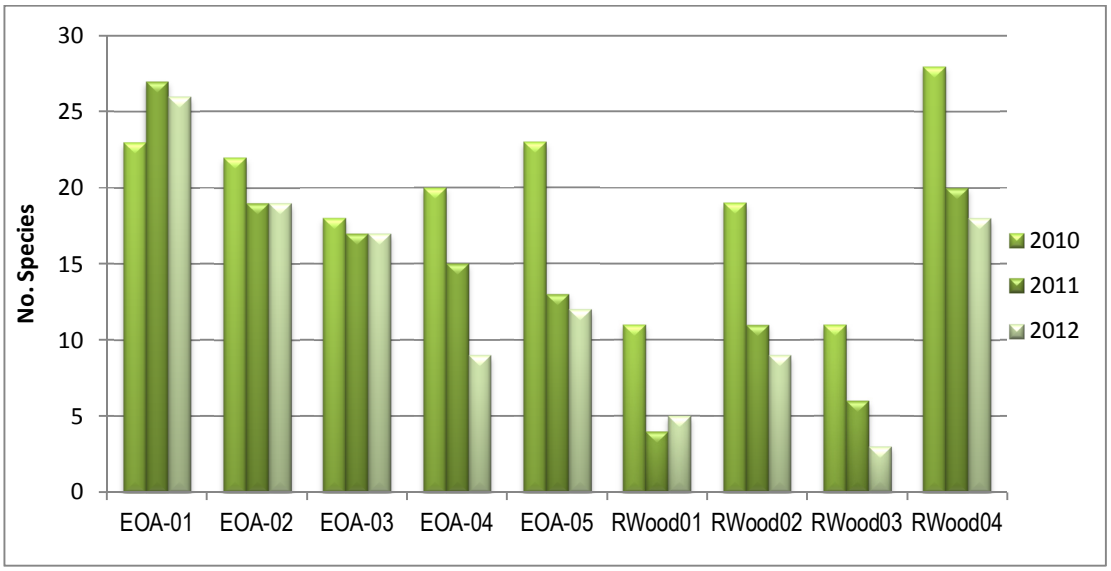


Figure 7-11. Total exotic species recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 - 2012.

7.6.4 Percent endemic ground cover

In 2012, the percent endemic ground cover was included as an additional ecological indicator to provide some measure of the cover abundance of the native vegetation and an indication of its weediness. In the woodland reference sites cover provided by native species appears to be increasing in most cases and this was also observed in EOA-05 and perhaps in EOA-01. A small decline in endemic cover was however observed in EOA-02, EOA-03 and EOA-04 and is probably in response to the seasonal conditions.

This year native species provided 87.8 – 95.8% of the total live plant cover in the woodland reference sites and with 96.4% and 96.3% EOA-04 and EOA-05 met this ecological target while the remaining sites did not and are presently weedier than desired. Sites EOA-01 and EOA-02 had comparatively low native plant ground cover which ranged from 38.6% and 33.3% respectively but these are expected to improve over time as the exotic weeds begin to decline and the native perennials begin to establish. Site EOA-03 had a relatively high 81.3% endemic plant cover but some weeds have persisted in an old stock camp area.

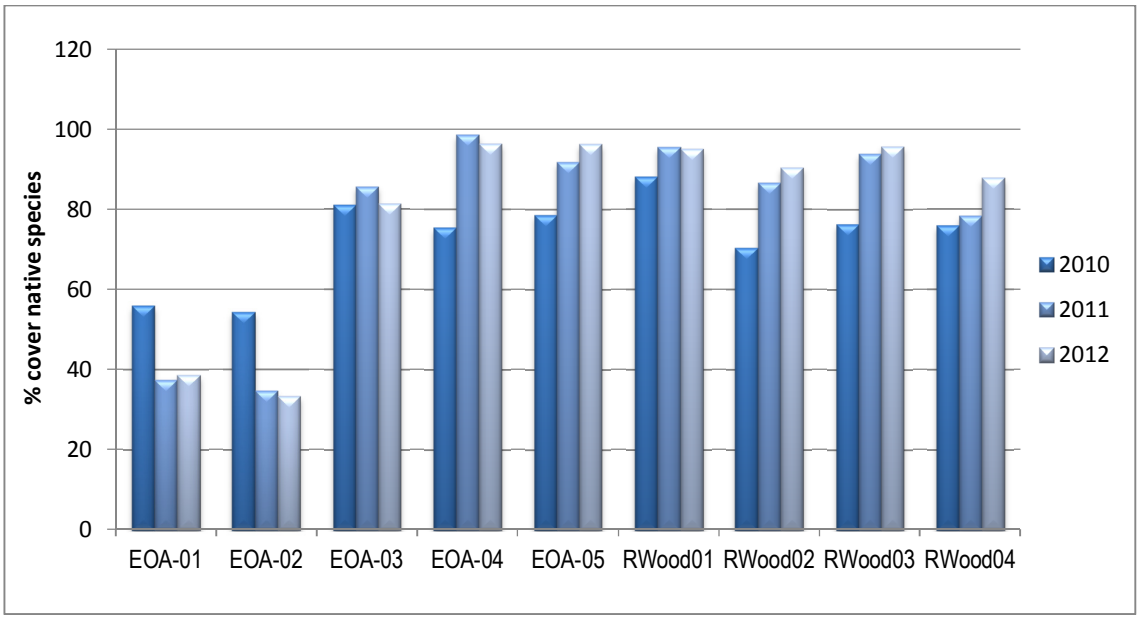


Figure 7-12. Percent endemic ground cover recorded in the woodland monitoring sites 2010 - 2012.

7.7 Most common species

Last year 143 species were recorded across the five Estcourt revegetation monitoring sites and of these 38 (27%) were exotic species. This year there were 105 species and of these 31 (30%) were exotic species (Appendix 1). The most common species (those that were recorded in at least four of the five monitoring plots) in 2012 is given in Table 7-3 and there were 27 of these.

In 2012, 14 species were common to all EOA monitoring sites and these included five native perennial grasses including *Austrodanthonia eriantha, Austrostipa scabra subsp. scabra, Chloris truncata, Enteropogon acicularis* and *Sporobolus caroli* and these were also common within the reference sites.

Common native herbs included *Calotis cuneifolia*, C. *lappulacea, Vittadinia cuneata var cuneata, Dichondra repens Wahlenbergia gracilis.* Other common natives included *Callitris glaucophylla* and *Carex inversa.* Common weeds were *Echium plantagineum* and *Lolium rigidum* and these were recorded in all EOA sites and were found in some of the reference sites. *Vittadinia cuneata var cuneata* and *Wahlenbergia gracilis* were native species found within all EOA sites but were not recorded within the reference sites, however other species of *Vittadinia* were very common. A comprehensive list of species recorded in all monitoring sites in 2012 has been included in Appendix 1.

Table 7-3. Species that were recorded in at least four of the five EOA revegetation monitoring sites in 2012.

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	Total	RWood01	RWood02	RWood03	RWood04
Coniferopsida	Cupressaceae		*Callitris glaucophylla*	White Cypress Pine	t	1	1	1	1	1	5	1	1		1
Dicotyledon	Asteraceae		*Calotis cuneifolia*	Purple Burr Daisy	h	1	1	1	1	1	5	1		1	
Dicotyledon	Asteraceae		*Calotis lappulacea*	Yellow Burr Daisy	h	1	1	1	1	1	5	1	1	1	
Dicotyledon	Asteraceae		*Vittadinia cuneata var cuneata*	Fuzzweed	h	1	1	1	1	1	5				
Dicotyledon	Campanulaceae		*Wahlenbergia gracilis*	Sprawling Bluebell	h	1	1	1	1	1	5				
Dicotyledon	Convolvulaceae		*Dichondra repens*	Kidney Weed	h	1	1	1	1	1	5	1	1	1	1
Dicotyledon	Plantaginaceae	*	*Echium plantagineum*	Paterson's Curse	h	1	1	1	1	1	5	1			1
Monocotyledon	Cyperaceae		*Carex inversa*	Knob Sedge	r	1	1	1	1	1	5				1
Monocotyledon	Poaceae		*Austrodanthonia eriantha*	Hill Wallaby Grass	g	1	1	1	1	1	5		1	1	
Monocotyledon	Poaceae		*Austrostipa scabra subsp. scabra*	Rough Speargrass	g	1	1	1	1	1	5	1	1	1	1
Monocotyledon	Poaceae		*Chloris truncata*	Windmill Grass	g	1	1	1	1	1	5	1		1	1
Monocotyledon	Poaceae		*Enteropogon acicularis*	Curly Windmill Grass	g	1	1	1	1	1	5	1	1	1	1
Monocotyledon	Poaceae	*	*Lolium rigidum*	Wimmera Ryegrass	g	1	1	1	1	1	5	1	1	1	1
Monocotyledon	Poaceae		*Sporobolus caroli*	Fairy Grass	g	1	1	1	1	1	5	1		1	
Dicotyledon	Asteraceae	*	*Carthamus lanatus*	Saffron Thistle	h	1	1	1	1		4				1
Dicotyledon	Asteraceae	*	*Lactuca serriola*	Prickly Lettuce	h	1	1	1		1	4				1
Dicotyledon	Asteraceae	*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1		1	4	1			1
Dicotyledon	Brassicaceae	*	*Lepidium africanum*	Peppercress	h	1		1	1	1	4				1
Dicotyledon	Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush	h	1	1	1		1	4		1	1	1
Dicotyledon	Convolvulaceae		*Convolvulus erubescens*	Australian Bindweed	h		1	1	1	1	4	1	1	1	1
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium arvense*	Haresfoot Clover	h	1	1	1	1		4				1
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium campestre*	Hop Clover	h	1	1	1		1	4				
Dicotyledon	Lamiaceae	*	*Salvia verbenaca*	Wild Sage	h	1		1	1	1	4	1	1		1
Monocotyledon	Poaceae		*Austrostipa bigeniculata*	Tall Speargrass	g	1		1	1	1	4		1	1	1
Monocotyledon	Poaceae		*Elymus scaber*	Common Wheatgrass	g		1	1	1	1	4	1	1	1	1
Monocotyledon	Poaceae		*Panicum sp.*		g	1	1	1		1	4		1	1	
Monocotyledon	Poaceae	*	*Vulpia sp.*		g	1	1	1		1	4				1

7.8 Vegetation composition

The composition of the vegetation as categorised by seven different growth forms is given in Figure 7-13. In the reference sites herbs were the most dominant growth form with 19 - 41 different species followed by grasses which had 10 – 18 species. There were 2 - 4 tree species, 1 - 3 shrub species and 1 - 7 different sub-shrubs. There may also have been a reed or fern species within some but not all of the reference sites.

Compared to the reference sites it appears that the composition of the EOA woodland sites are imitating that of the woodland reference sites but notable differences include the lack of tree and shrub species, and in EOA-03 there were no sub-shrubs. The diversity of herb, grass, reed and fern species were presently similar to or exceeded that recorded in the reference sites.

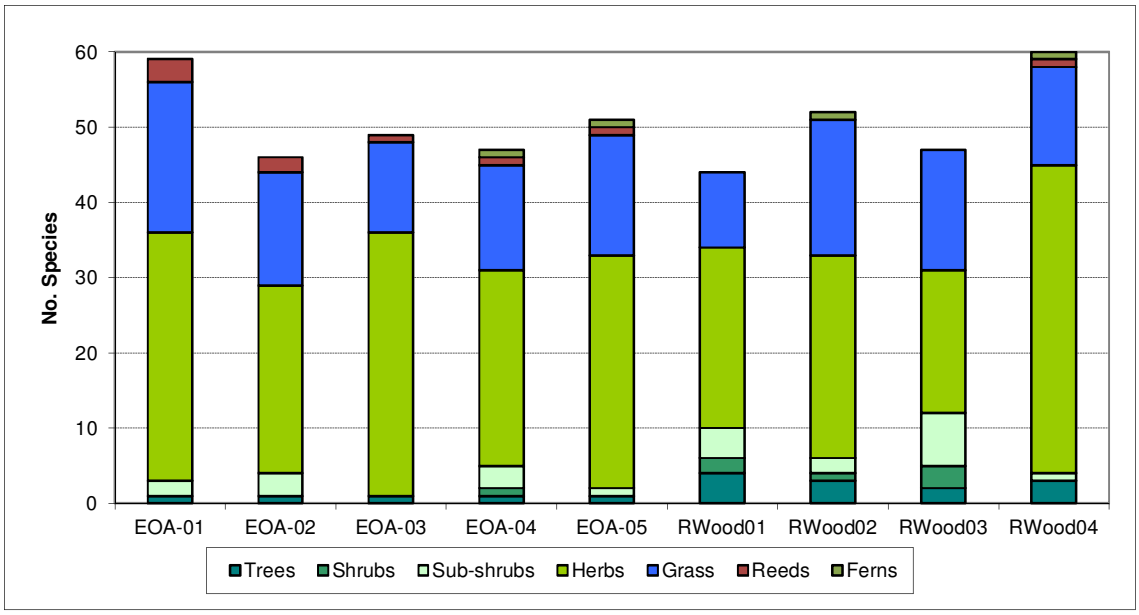


Figure 7-13. Composition of the vegetation recorded in the Estcourt Offset sites compared to the woodland reference sites 2010 - 2012.

7.9 Soil analyses

7.9.1 pH

Figure 7-14 shows the pH recorded in the EOA woodland sites compared to the upper and lower pH values recorded in the woodland reference sites and prescribed “desirable” levels in medium soils. There were negligible changes in pH across the range of monitoring sites and any changes were likely to be attributed to natural sampling variability. The reference sites provided a pH range of 6.48 – 6.87 and all EOA sites continued to be slightly lower than this range. This year EOA-05 had the lowest pH of 6.14 and was slightly acidic (Bruce & Rayment 1982). The highest pH was recorded in EOA-02 with a ph of 6.24 and this was marginally lower than the minimum pH target. All EOA sites however fell within the desirable pH range of 5.6 – 7.3.

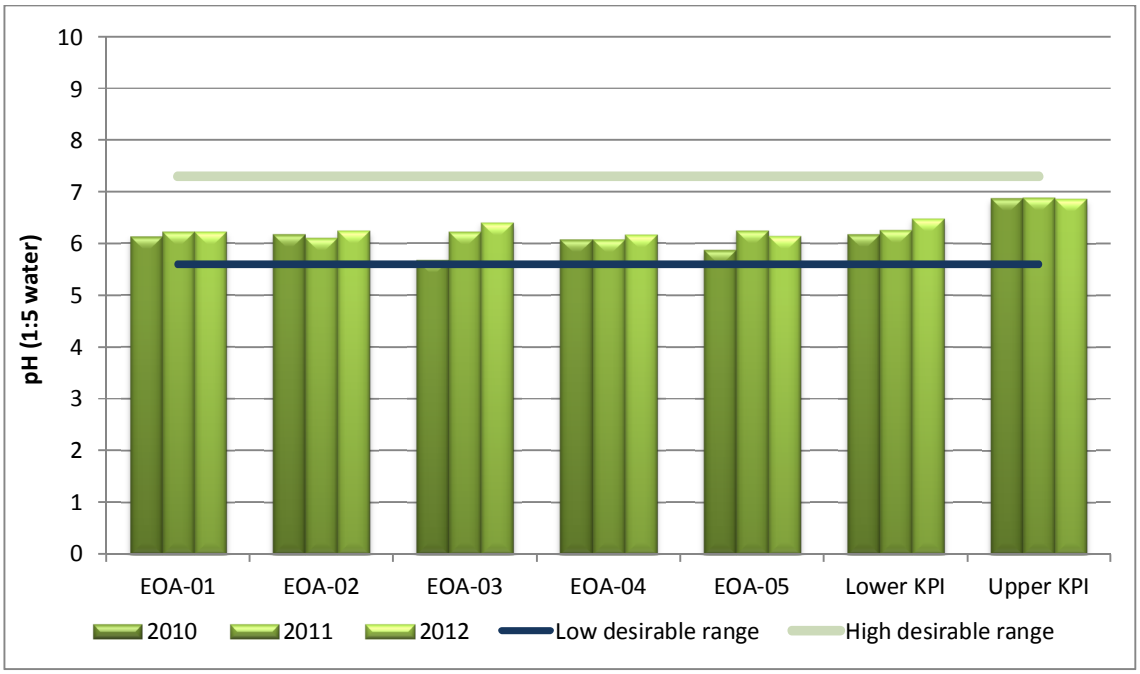


Figure 7-14. Comparison of pH values recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.2 Conductivity

Figure 7-15 shows the Electrical Conductivity (EC) recorded in the EOA sites, the lower and upper values of the woodland reference sites as well as the "desirable" level provided by the laboratory in medium soils. This year there were no consistent changes across the range of sites but the EC range has narrowed to provide a target range of 0.055 – 0.077 dS/m and at these levels they continued to fall well below the desirable thresholds indicating there were low levels of soluble salts in the soil profile. There was a slight increase in EC recorded in EOA-02 this year and while it exceeded the local levels, it continued to fall well below the desirable levels of 0.150 dS/m. Site EOA-04 was negligible higher than the target range while the remaining EOA monitoring sites were within local EC levels.

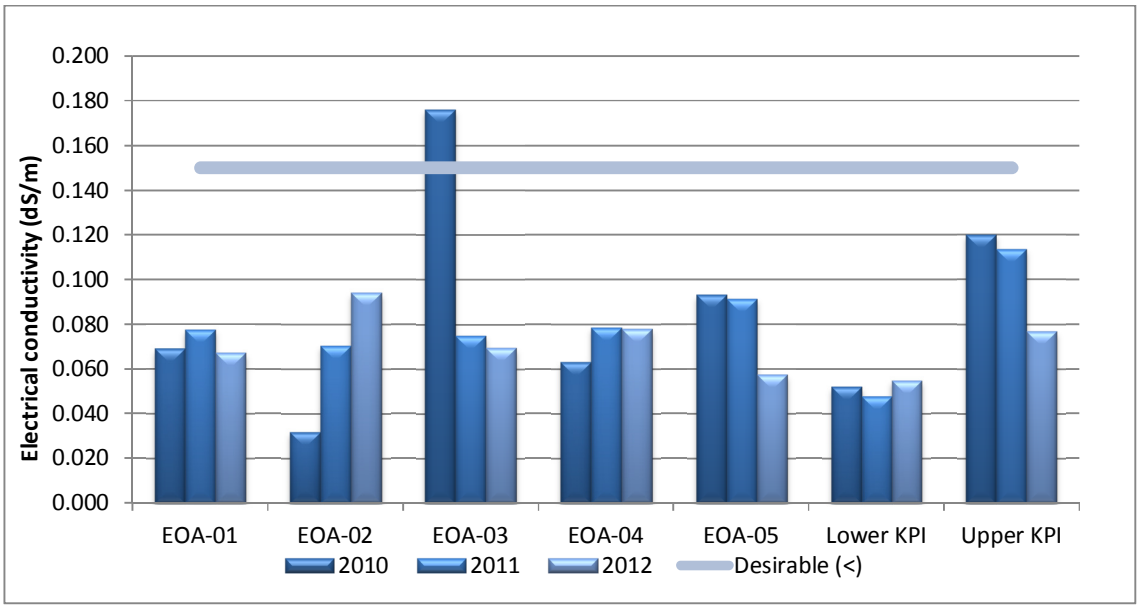


Figure 7-15. Comparison of conductivity values recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.3 Organic Matter

There have been no consistent changes in OM recorded in any monitoring site and this year the OM range in the reference sites has narrowed to 4.31 – 6.34%, with the high OM levels recorded in RWood04 due to the occurrence of an old stockcamp demonstrating a significant decline this year (Figure 7-16). The derived grassland sites EOA-01 and EOA-02 continued to have low OM levels as a result of their agricultural history and had OM levels of 3.3% and 3.9%. Sites EOA-3, EOA-04 and EOA-5 continued to fall within the target range and were higher than the desirable level despite a minor decrease in EOA-03 and EOA-05 which was probably associated with the site and sampling variability.

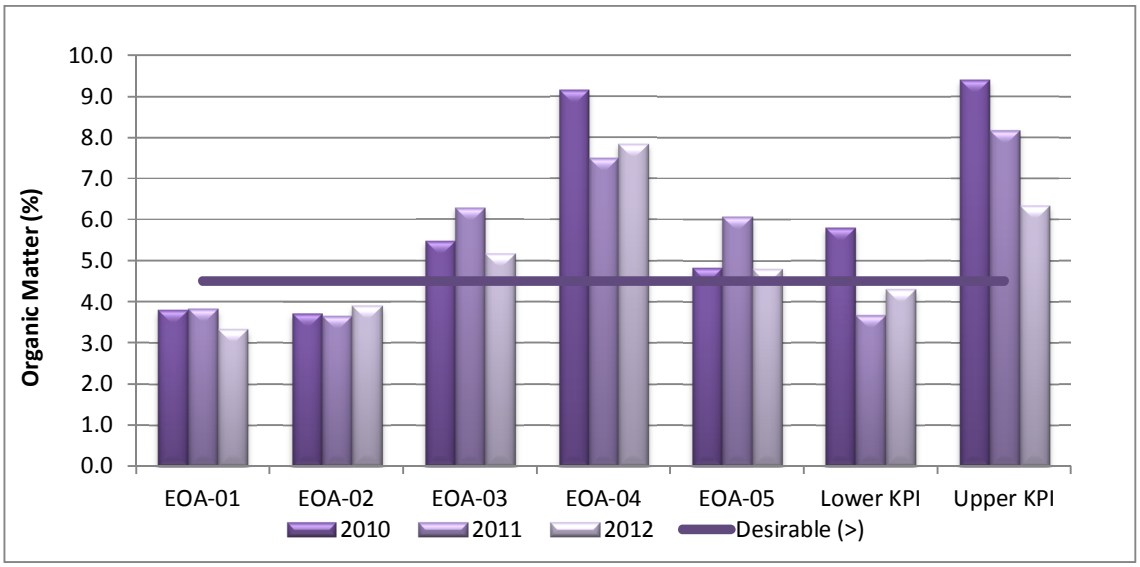


Figure 7-16. Comparison of organic matter recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.4 Phosphorous

Phosphorous levels have continued to decline across the range of EOA monitoring sites except in EOA-01 and this year phosphorous levels in the woodland reference sites ranged from 14.5 – 23.6 mg/kg and these continued to be well below the "desirable" level reflecting the naturally low soil fertility in the area (Figure 7-17). Phosphorous levels in the derived grassland EOA-01 continued to exceed the reference target range as well as the desirable levels probably due to its long cropping history. The remaining sites fell within the reference target range.

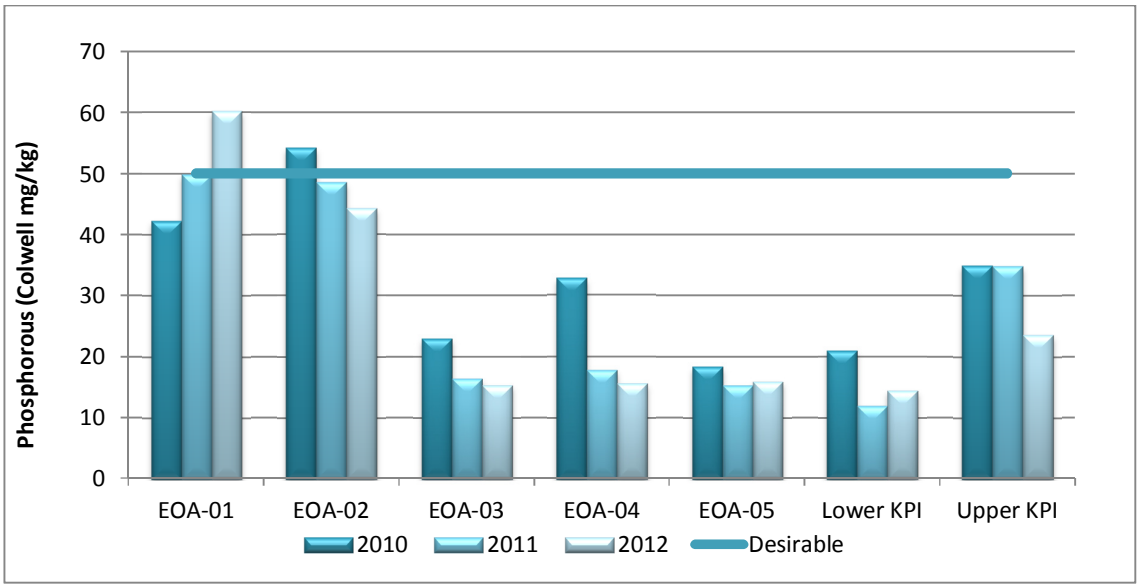


Figure 7-17. Comparison of phosphorous levels recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.5 Nitrate

There has been no consistent trend in changes across the monitoring sites but the most significant changes occurred in site EOA-03 and EOA-05 between 2010 and 2011 probably due to higher rainfall activity (Figure 7-18). The nitrate range in the reference sites have narrowed this year to provide a target of 2.7 – 7.3 mg/kg which was considerably lower than desirable levels and is a reflection of the low fertility soils and the unpredictable nature of N cycles within the soil profiles, which can also be affected by seasonal conditions. Nitrate levels in the two derived grassland sites were slightly lower than local levels but the remaining EOA fell within the target range.

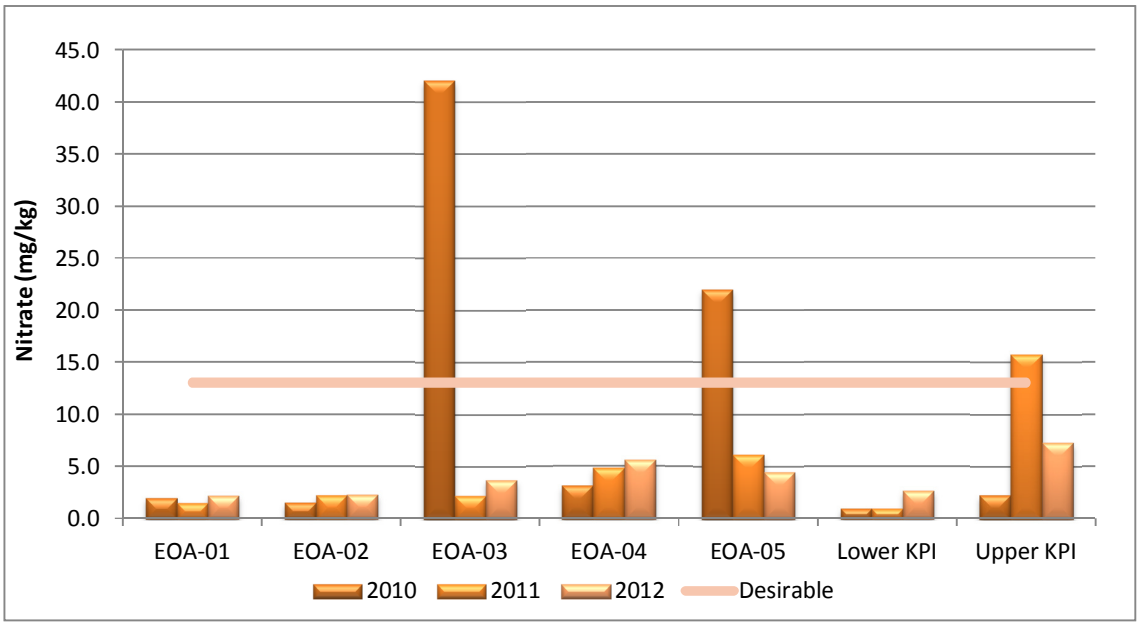


Figure 7-18. Comparison of Nitrate levels recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.6 Cation Exchange Capacity

Cation Exchange Capacity (CEC) is the capacity of the soil to hold the major cations (Calcium, Magnesium, Sodium and Potassium) and is also a measure of the potential fertility of the soil. Since 2010 there has been no consistent trend in the changes in CEC across all monitoring sites most changes being relatively minor. This year the reference sites provided a range of 14.08 – 19.06 cmol/kg and these were similar to or exceeded the desirable level (Figure 7-19). Estcourt revegetation sites EOA-01, EOA-02 and EOA-03 continued to have a low CEC with CEC values of 11.42, 11.43 and 11.14 cmol/kg respectively and this year CEC was low in EOA-05. Site EOA-4 continued to fall within the local target range and was higher than the desirable level.

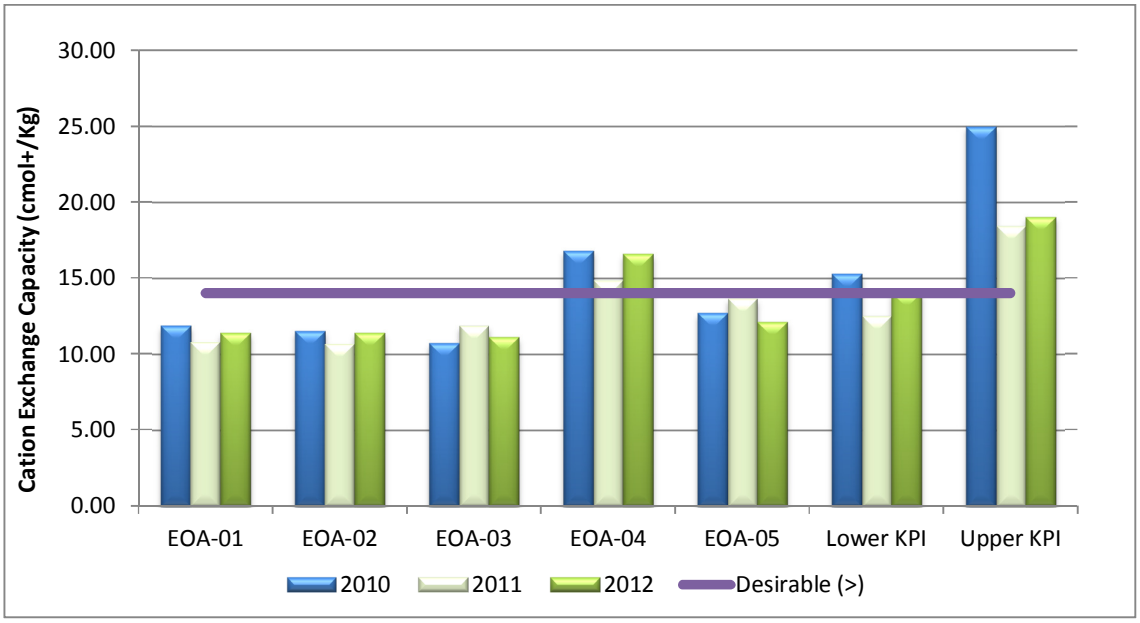


Figure 7-19. Comparison of Cation Exchange Capacity recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level in 2010, 2011 and 2012.

7.9.7 Exchangeable Sodium Percentage

Sodicity refers to a significant proportion of Sodium in the soil compared to other cations with soil considered to be sodic when there is sufficient sodium to interfere with its structural stability which often interferes with plant growth. Sodic soils tend to suffer from poor soil structure including hard soil, hardpans, surface crusting and rain pooling on the surface, which can affect water infiltration, drainage, plant growth, cultivation and site accessibility.

All of the EOA monitoring sites and reference sites continued to have non sodic soils and were below the desirable levels of 5% ESP (Figure 7-20) and in most cases there have been marginal changes over the past year. The reference sites provided a slightly lower range of 0.16 – 1.74% and sites EOA-01 (3.49%) and EOA-02 (2.83%) continued to exceed this local range.

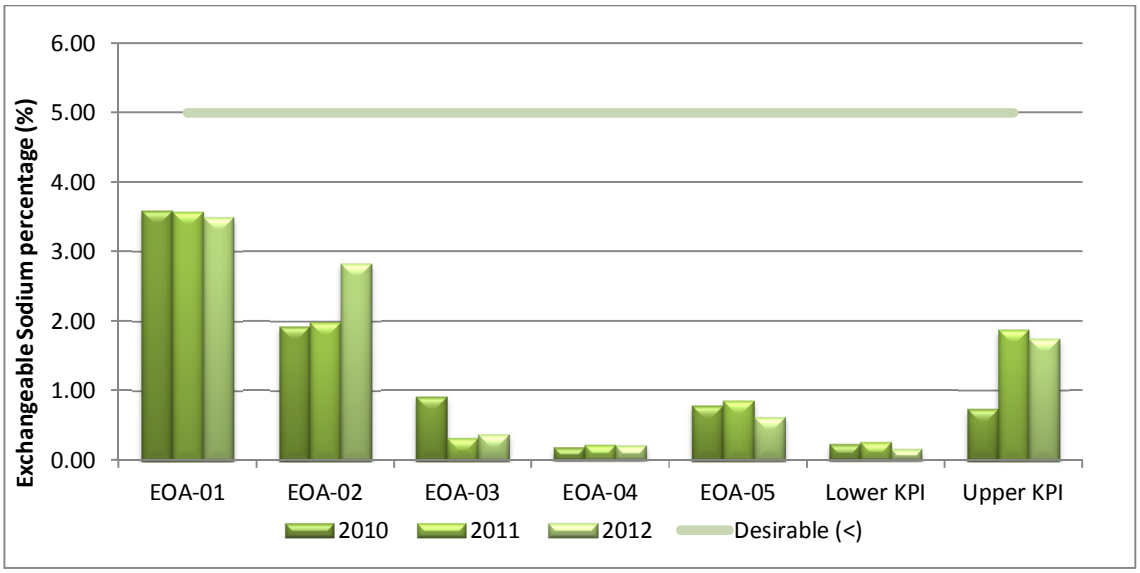


Figure 7-20. Comparison of ESP recorded in the Estcourt Offset sites compared to the upper and lower values from the woodland reference sites and the desirable level 2010 - 2012.

7.9.8 Other soil tests

The full results of the soil analysis are provided in Appendix 2 but a summarised version highlighting abnormal results is provided in Table 7-4. The results indicate there are numerous elements which occur at elevated levels in the Estcourt revegetation sites, however in most cases these are also found to be elevated within the woodland reference sites. As these Estcourt monitoring sites are essentially modified farmland (rather than disturbed mine rehabilitation areas), the results tend to indicate that various elements occur at naturally higher levels within soils surrounding the Northparkes Mine, especially Magnesium, Potassium, Manganese and Iron.

Table 7-4. Summarised soil analyses highlighting abnormal test results.

Method		*Nutrient*		*Units*	**EOA-01**	**EOA-02**	**EOA-03**	**EOA-04**	**EOA-05**	**RWood01**	**RWood02**	**RWood03**	**RWood04**	***Indicative guidelines only- refer Note 6***
	Morgan 1	Calcium	Ca	mg/kg	552	614	812	1235	795	909	1347	777	1113	*750*
		Magnesium	Mg		282	254	174	205	224	350	378	395	283	*105*
		Potassium	K		315	374	304	243	289	273	204	199	349	*75*
	KCl	Sulfur	S	mg/kg	4.4	6.8	9.2	10.6	7.9	9.2	8.5	6.9	8.4	*8.0*
	DTPA	Zinc	Zn	mg/kg	1.1	1.4	1.4	3.8	1.5	2.0	1.5	1.2	11.9	*5.0*
		Manganese	Mn		75	87	40	142	92	202	46	62	104	*22*
		Iron	Fe		101	103	60	87	98	65	39	45	52	*22*
		Copper	Cu		4.3	5.9	6.4	9.3	4.8	4.7	12.2	4.1	23.2	*2.0*
	$CaCl_2$	Silicon	Si	mg/kg	97	95	74	71	70	58	70	59	73	*45*
	Total Acid Extractable	Zinc	Zn	mg/kg	20	28	29	56	28	36	50	29	223	*20 - 50 Zn*
		Manganese	Mn		938	998	464	1,766	1,070	3,740	948	856	2,176	*200 - 2,000 Mn*
		Copper	Cu		31.2	43.2	97.2	80.2	36.3	39.6	101.3	35.2	162.9	*20 - 50 Cu*
		Chromium	Cr	mg/kg	22	25	17	24	27	23	111	22	22	*<25 Cr*

Brown = exceptionally high; Red = very high; Yellow = moderately high; Green = slightly high

8 Estcourt Offset site performance towards meeting completion criteria targets

Table 8-1 indicates the performance of the Estcourt Offset monitoring sites against a selection of proposed Completion Performance Indicators developed for woodland communities during the 2012 monitoring period. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment (orange) and ending with indicators of ecological stability (blue). The range values are amended annually.

Revegetation sites meeting or exceeding the range values of their representative community type have been identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 8-1. Performance of the Estcourt Offset monitoring sites against a selection of proposed Completion Performance Indicators or completion criteria.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01	EOA-02	EOA-03	EOA-04	EOA-05
Performance indicators are quantified by the range of values obtained from replicated reference sites						Lower	Upper	2012	2012	2012	2012	2012
Landform establishment and stability	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation	%	63.5	71.0	75.5	74.5	73.0	73.5	73.5
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation	%	44.4	52.8	42.3	40.7	52.0	52.7	48.9
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation	%	40.9	51.6	42.7	42.3	49.6	48.3	46.0
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation	%	100	100	100	100	100	100	100
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising	No.	0	0	0	0	0	0	0
Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry	pH (5.6 - 7.3)	6.5	6.9	6.22	6.24	6.40	6.16	6.14
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry	% (>4.5)	4.3	6.3	3.3	3.9	5.2	7.8	4.8

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01	EOA-02	EOA-03	EOA-04	EOA-05
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (>12.5)	2.7	7.3	2.2	2.3	3.8	5.6	4.5
Ecosystem establishment	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.	species/area	1	6	1	1	1	2	1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation	% population	100	100	100	100	100	100	100
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation	<No./area	3	18	26	19	17	9	12
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation	No./area	30	134	7	24	7	10	11
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	2	4	1	1	1	1	1
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	3	0	0	0	1	0
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	19	41	33	25	35	26	31
Ecosystem development and habitat complexity	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation	%	9	36	7	20	43.5	37.5	27
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation	%	87	99	99.5	100	100	99.5	100
	Ground cover diversity	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation	%	88	96	38.6	33.3	81.3	96.4	96.3
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	5	48	7	24	7	8	11
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	19	0	0	0	0	0
Ecological stability	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	0	8	0	7.5	0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01	EOA-02	EOA-03	EOA-04	EOA-05
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	15	44	0	0	0	24	8
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity	The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation	%	100	100	0	0	0	100	100
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation	% population	83	100	0	0	0	66.7	60
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation	% population	0	42	0	0	0	9.5	60.0
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation	% population	47	89	0	0	0	52.4	60

9 Recommendations and management actions

The EOA monitoring sites have slightly lower ecological function since 2011 however this was also reflected in the reference sites and is largely due to the prolonged dry seasonal conditions. Nonetheless all sites fell within the LFA related target ranges with the exception of the recovering grassland areas which had low infiltration capacity due to the development of increasingly hard soil surface crusts. In these sites organic matter and nitrates were deficient and in EOA-01 phosphorus concentrations were higher than desirable as a result of their long agricultural history.

This year ecological attributes which fell short of meeting the target ranges were largely associated with low native species diversity and in the derived grassland, annual exotic species remained dominant and were weedier than desired. Despite natural recruitment being recorded in all sites this year, there continued to a low density of shrubs and juvenile trees and a low diversity of tree species in all EOA sites. Many ecological attributes that were not met were largely related to the mature tree population and the structural complexity of the sites due to the lack of a well developed overstorey.

The proposed revegetation activity within the EOA (GHD 2010) aims to increase biodiversity and habitat values through tubestock planting within the more cleared grassland areas (eg EOA-01 and EOA-02) and encourage natural regeneration within more open woodland areas (eg EOA-03, EOA-04 and EOA-05) combined with supplementary planting of shrubs which were currently limited in distribution across the conservation area. Care should be taken to limit disturbance or additional planting in areas that are already successfully regenerating at least in the short term, until active regeneration requirements can clearly be identified.

While the composition of the ground cover in the cleared grassland sites contained a high proportion of exotic species these sites have demonstrated a significant improvement in many other ecological attributes indicating a positive successional response. However the extreme seasonal conditions between monitoring years has had a significant effect on the ground cover composition in all sites therefore profound changes in ecological recovery should also be considered with a degree of flexibility. While some sites contained many weedy species, these species are part of the successional process and will make a positive contribution in providing protective ground cover and assisting with the development of the microbial and nutrient recycling process and most species are likely to decline in abundance over time. However some species are also common components of the native grasslands and agricultural land in the local NPM environment and therefore some species are likely to persist and these will be reflected in the reference sites.

There are few other management issues that have not already been addressed in the Rehabilitation Management Plan (GHD 2010).

Regular slashing of the main access tracks is recommended to allow safe and easy access for maintenance and monitoring of the sites.

10 Individual site descriptions

10.1 EOA-01 site description

EOA-01 is a derived grassland situated in the northeast of the Estcourt Offset Area. The site was an old cropping paddock that has not been recently grazed.

In 2010 it contained a diverse understorey of native and introduced species including *Dicondra repens*, *Hordeum leporinum, Chloris truncata* and *Medicago polymorpha*. There was high floristic diversity (57 species) and native species (34) were more abundant than exotic species (23). There was good ground cover with perennial plants providing 30.5% of the ground cover. Annuals provided 30.5% and cryptogams were moderately abundant. There were scattered occurrences of *Echium plantagineum, Arctotheca calendula, Centaurea melitensis* and *Sonchus oleraceus*. In 2011, there were increased levels of ground over, decreased abundance of cryptogams but maintained a high diversity of native and exotic species. In 2012 the site was similar to but drier than last year and seven *C. glaucophylla* seedlings were found.

10.1.1 Landscape Function Analysis

10.1.1.1 Landscape organisation

EOA-01 continued to be characterised as a grassland patch and with excellent ground cover scored a Landscape Organisation Index of 1.0 and was 100% capable of harnessing mobile resources (Figure 10-1, Table 10-1). Between 2010 and 2011 there was a marginal improvement in ecological function largely due to increased levels of litter cover which have begun to accumulate some depth across most of the site and slightly increased soil surface relief. In 2012 however there was slight decline in ecological function due to slightly less levels of litter and cryptogam cover.

The resultant LFA indices for stability, infiltration and nutrient recycling were 75.5, 42.3 and 42.7 respectively. While all LFA related targets were met last year, stability and nutrient recycling indices were 12 and 1.8 LFA units higher than the minimum target range but infiltration was 2.1 LFA units lower.

Figure 10-1. Permanent photo point taken from the top of the LFA transect in 2011 (left) and 2012 (right).

Table 10-1. Summary of landscape organisation and LFA indices in 2010, 2011 and 2012.

EOA-01		24/9/2010		20/10/2011		18/10/2012	
Number of Patches/10m		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		NA		NA	
Range Interpatch length (m)		NA		NA		NA	
Patch or Interpatch Type		**Grassland Patch**		**Grassland Patch**		**Grassland Patch**	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment							
Within Individual Zones	**Stability**	77.5		78.5		75.5	
	Infiltration	43.3		44.5		42.3	
	Nutrients	44.6		47.4		42.7	
			Total		**Total**		**Total**
Individual zones contribution to the whole of Landscape	**Stability**	77.5	**77.5**	78.5	**78.5**	75.5	**75.5**
	Infiltration	43.3	**43.3**	44.5	**44.5**	42.3	**42.3**
	Nutrients	44.6	**44.6**	47.4	**47.4**	42.7	**42.7**

10.1.1.2 Soil Surface Assessment

In the grassland patch, there continued to be variable but typically moderate to moderately high protection from rain splash due to the occurrence of scattered perennial plants which also provided low to moderate basal cover (Table 10-2), however there continued to be a lack of perennial plant cover towards the end of the transect (Rep 5). This year there was slightly less cover provided by annual plants and dead leaf litter (litter) and cryptogams but there continued to be evidence of slight rates of decomposition which is a particularly important attribute in terms of nutrient recycling and indicates a presence of microbial and fungal activity. The soil surface remained crusted across the site and while cryptogams were slightly less abundant, this was due to increasing litter and plant cover and typically they remained in moderate to high abundance across the site. There continued to be moderate soil surface relief which was provided by the scattered grass tussocks and there was little evidence of erosion or deposition despite the high rainfall activity over summer. The clay loam soils were moderately hard to very hard and the slake test continued to indicate the soils were very stable.

Table 10-2 . Results of the Soils Surface Assessment for the Grassland patch.

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Soil Cover	5	5	4	2	2	1
Per. basal / canopy cover	4	4	2	2	2	1
Litter cover, orig & incorp.	10	5ls	5ls	6ls	6ls	6ls
Cryptogam cover	4	2	2	3	3	1
Crust broken-ness	4	4	4	4	4	4
Erosion type & severity	4	4	4	4	4	4
Deposited materials	4	4	4	4	4	4
Soil surface roughness	5	3	3	3	2	3
Surface resist. to disturb.	5	4	4	3	3	4
Slake test	4	4	4	4	4	4
Texture	4	2	2	2	2	2

10.1.2 Soil analyses

There has been little to no changes in the soil characteristics since 2010 and in all cases any change has been relatively insignificant. The soils remained slightly acidic and while they were slightly lower than the reference sites they continued to fall within the desirable levels prescribed by the agricultural industry (Table 10-3). The Electrical Conductivity continued to fall within local levels but Organic Matter content, Nitrate and CEC levels were low. There has been a slight increase in Phosphorous levels which continued to be higher than local woodland areas as a result of the previous cultivation history, and this year these concentrations slightly exceeded desirable levels. There was little change in the Exchangeable Sodium Percentage (ESP) which remained higher than the reference sites but well below the desirable level of 5% indicating that the soils are non sodic.

Table 10-3. Results of the soil analysis for EOA-01 compared to the upper and lower values for the woodland reference sites and desirable levels in 2010, 2011 and 2012.

Nutrient	Units	EOA-01			Lower KPI	Upper KPI	*Desirable Level*
		2010	**2011**	**2012**			
pH (1:5 water)	units	6.13	6.22	6.22	6.48	6.87	*5.6 – 7.3*
Conductivity (1:5 water)	dS/m	0.069	0.078	0.067	0.05	0.08	*0.150*
Organic Matter	%	3.8	3.8	3.3	4.31	6.34	*>4.5*
Phosphorus (Colwell)	mg/kg	42	50	60	14.46	23.62	*50*
Nitrate	mg/kg	2.0	1.5	2.2	2.68	7.32	*13.0*
Cation Exchange Capacity	$cmol^+/Kg$	11.90	10.83	11.42	14.08	19.06	*14.00*
Exchangeable Sodium Percentage	%	3.59	3.57	3.49	0.16	1.74	<5

10.1.3 Rill assessment

No rills were observed within the monitoring quadrat in any monitoring year.

10.1.4 Tree density and health condition

No trees or shrubs with a stem dbh >5cm were recorded within this site.

10.1.5 Shrubs and regeneration

This year there were six additional *Callitris glaucophylla* seedlings as a result of natural recruitment resulting in a population of seven. All seven individuals were less than 0.5m in height and at the time of monitoring were approximately 5-10cm tall. Many other juvenile *C. glaucophylla, E. microcarpa* and *E. populnea* were now visible within the larger paddock areas a result of natural recruitment stimulated by the good summer rainfall over the past two years.

Table 10-4.Shrubs and young trees occurring within the monitoring site.

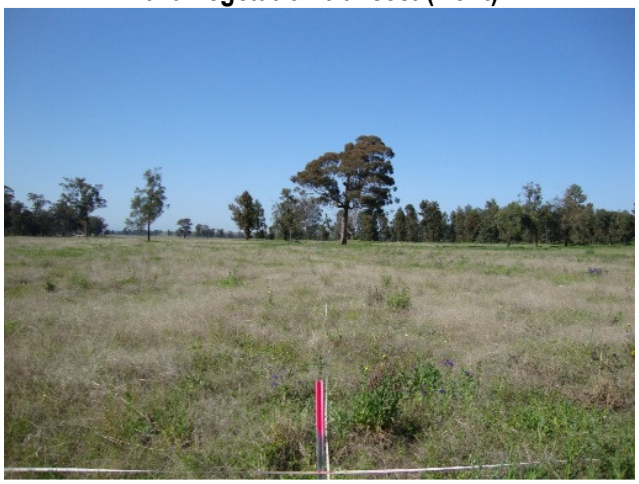
Species	0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	>2.0m	Total	endemic	not endemic
Callitris glaucophylla	7					**7**	7	
Total	**7**	**0**	**0**	**0**	**0**	**7**	**7**	**0**
% endemic species							**100**	**0**

10.1.6 Structural diversity and habitat complexity

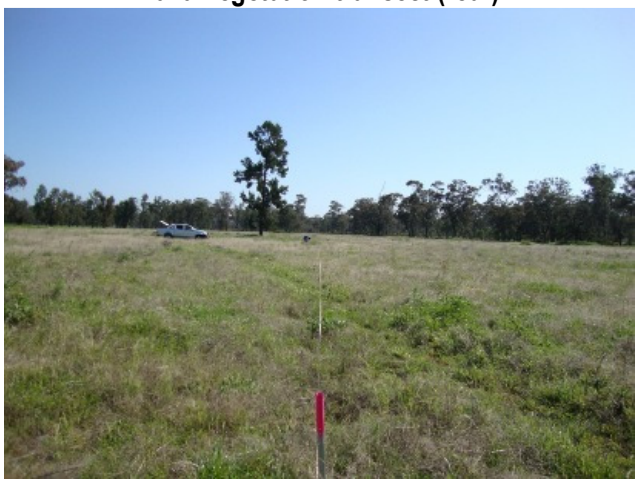
There has been very little change in the overall structure of this recovering native grassland which remains devoid of a shrub and canopy layer (Figure 10-2). The site continues to be structurally simple however total ground cover has slightly declined from 100 -99.5% as there was one small bare patch recorded at 15m along the transect (Figure 10-3). The understorey continued to be dominated by dead leaf litter and annual plants but due to the prolonged dry conditions there was reductions in annual and perennial plant growth, resulting in an increase in dead litter cover this year.

A small log was recorded for the first time there continued to be no other habitat features such as cryptogam or rocks. With the relatively dry spring weather combined with some macropod grazing the there was no projected foliage cover greater than 0.5m in height this year. Table 10-5 provides the average and minimum and maximum values obtained along the vegetation transect in 2012.

2010 Vegetation transect (front)



2010 Vegetation transect (rear)



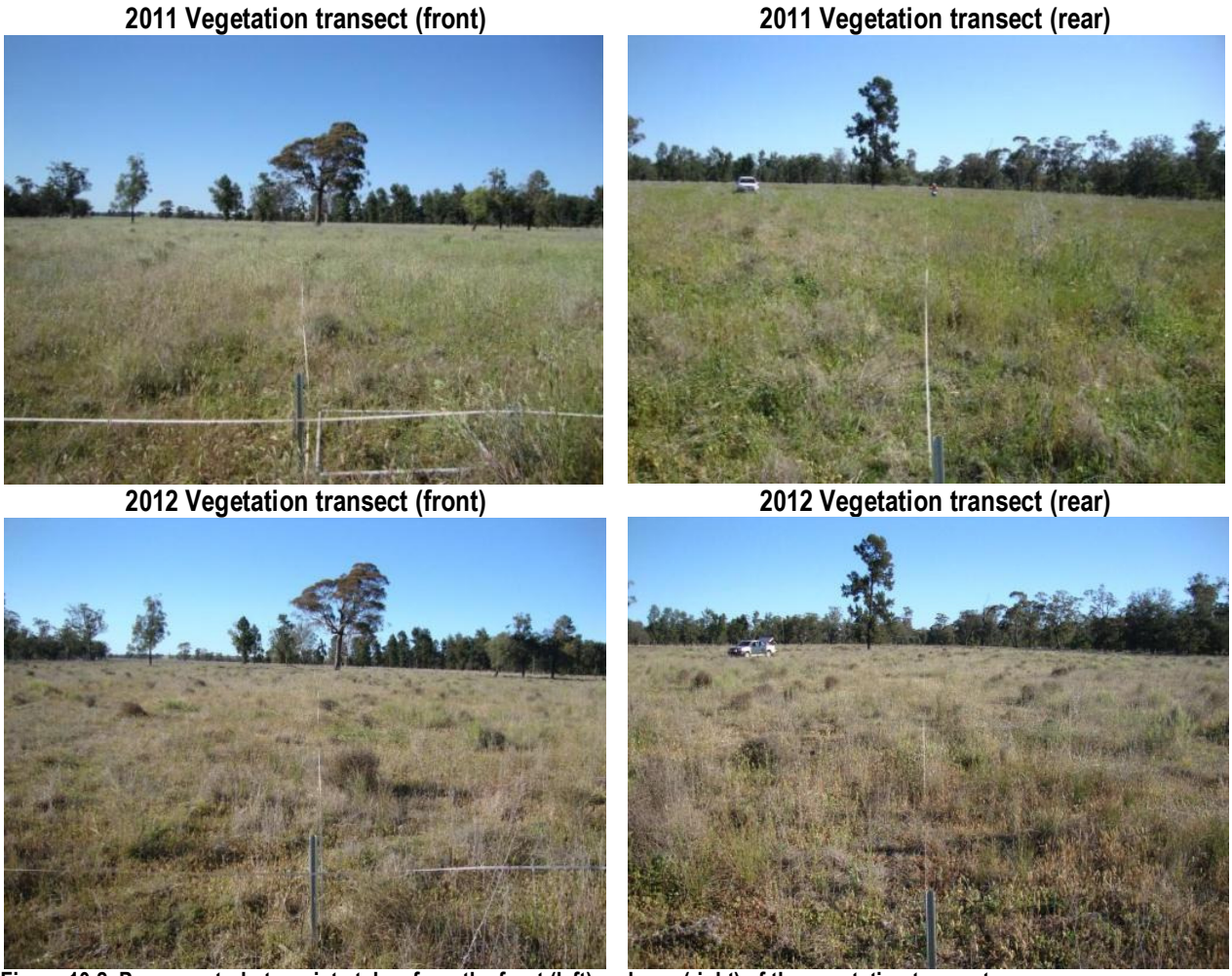


Figure 10-2. Permanent photo points taken from the front (left) and rear (right) of the vegetation transect.

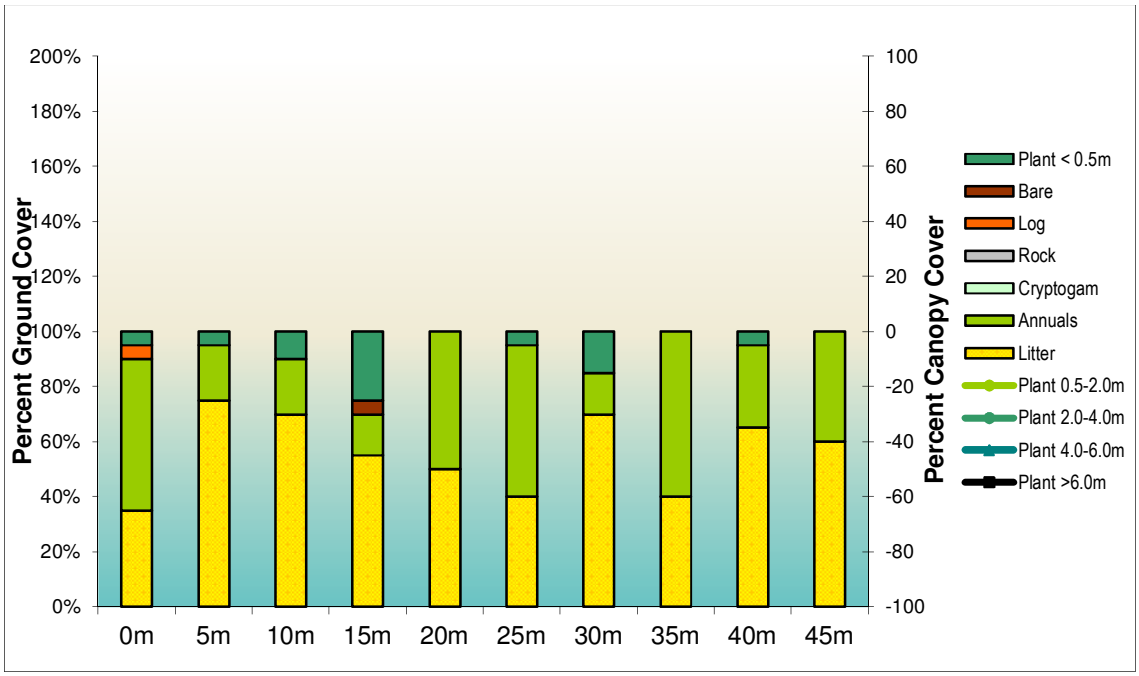


Figure 10-3. Graph illustrating the structural diversity and habitat complexity of the monitoring site.

Table 10-5. Average and minimum and maximum values of the structural diversity of the monitoring site.

Vegetation structure	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m	Average	Min	Max
Litter	35	75	70	55	50	40	70	40	65	60	**56**	**35**	**75**
Annuals	55	20	20	15	50	55	15	60	30	40	**36**	**15**	**60**
Cryptogam	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Rock	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Log	5	0	0	0	0	0	0	0	0	0	**0.5**	**0**	**5**
Bare	0	0	0	5	0	0	0	0	0	0	**0.5**	**0**	**5**
Perennial <0.5m	5	5	10	25	0	5	15	0	5	0	**7**	**0**	**25**
Total Ground Cover	100	100	100	95	100	100	100	100	100	100	**99.5**	**95**	**100**
0.5-2.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
2.0-4.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
4.0-6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
>6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**

10.1.7 Species cover abundance

There was one less species recorded in the five 1m^2 quadrats on the permanent vegetation transect line this year with a total of 29 species including 17 exotic species. Using the Braun-blanquet scale, the highest possible cover score that can be obtained is 30 and cover abundance is illustrated as a sum of scores (class values) obtained along the five 1m^2 quadrats.

Figure 10-4 and Table 10-6 illustrates that the site continues to have high ground cover diversity with *Medicago truncatula* the most common and abundant species while *Bromus molliformis* and the native grass species *Chloris truncata* were equally the second most common and abundant species. While dominant in 2011, the exotic *Trifolium* species were considerably less abundant in 2012. *Wahlenbergia gracilis* a native forb was also recorded in all replicates but provided comparatively less cover. Other relatively common species were the exotic annuals *Lactuca saligna*, *L. serriola, Sonchus oleraceus, Trifolium campestre* and *T. subterraneum* and these were recorded in at least four of the replicates but typically provided low cover abundance scores. There has been a noticeable decline in the abundance of *Conyza bonariensis* and *Trifolium* species this year. The remaining species were less common and/or provided lower cover values. Of the live plant cover scores recorded 38.6% was provided by native species.

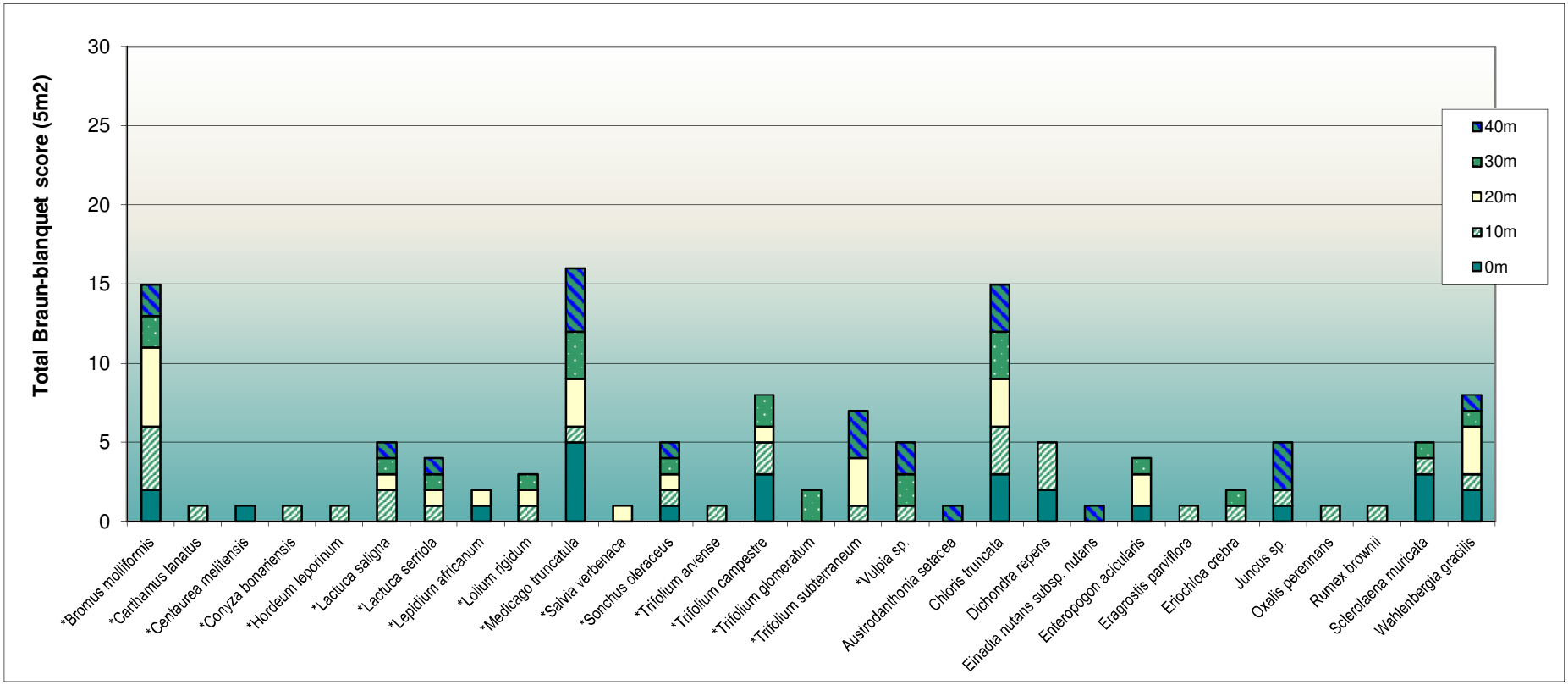


Figure 10-4. Total species recorded across the five, 1m² quadrats using the Braun-blanquet scale (max possible score is 30) as a measure of cover abundance.

Table 10-6. List of species and their average cover abundance score across the five, 1m² monitoring quadrats.

Species	0m	10m	20m	30m	40m	Total
**Bromus molliformis*	2	4	5	2	2	15
**Carthamus lanatus*		1				1
**Centaurea melitensis*	1					1
**Conyza bonariensis*		1				1
**Hordeum leporinum*		1				1
**Lactuca saligna*		2	1	1	1	5
**Lactuca serriola*		1	1	1	1	4
**Lepidium africanum*	1		1			2
**Lolium rigidum*		1	1	1		3
**Medicago truncatula*	5	1	3	3	4	16
**Salvia verbenaca*			1			1
**Sonchus oleraceus*	1	1	1	1	1	5
**Trifolium arvense*		1				1
**Trifolium campestre*	3	2	1	2		8
**Trifolium glomeratum*				2		2
**Trifolium subterraneum*		1	3		3	7
**Vulpia sp.*		1		2	2	5
Austrodanthonia setacea					1	1
Chloris truncata	3	3	3	3	3	15
Dichondra repens	2	3				5
Einadia nutans subsp. nutans					1	1
Enteropogon acicularis	1		2	1		4
Eragrostis parviflora		1				1
Eriochloa crebra		1		1		2
Juncus sp.	1	1			3	5
Oxalis perennans		1				1
Rumex brownii		1				1
Sclerolaena muricata	3	1		1		5
Wahlenbergia gracilis	2	1	3	1	1	8
Total cover						127
Sum of cover of native species						49
Percent endemic species cover						**38.6**

10.1.8 Floristic diversity

The floristic diversity of the sites was measured using two different methods. One provides an assessment of the average number of species within five, one square metre (m²) sub-quadrats along the vegetation transect, while the other provides the total number of species within the entire 50x20m monitoring plot.

10.1.8.1 Species diversity per m²

There has continued to be a slight decline in native species diversity from 7.6 - 5.6 native species per m² on average, while the average number of exotic species remained consistent with 9 species per m² (Table 10-7). The number of native species ranged between 3 – 9 species per m², while the number of exotic species ranged between 6 – 13 species per m².

Table 10-7. Species diversity per 1m².

Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	6	9	3	5	5	**5.6**	2.2
Exotic	6	13	10	9	7	**9**	2.7
Total	**12**	**22**	**13**	**14**	**12**	**14.6**	4.2

10.1.8.2 Total species diversity

The total floristic diversity has increased by one species this year to provide a total of 33 different species recorded within the 50 x 20m monitoring quadrat. There was however two additional native species and one less exotic species to provide a total native and total exotic diversity of 33 and 26 species respectively (Figure 10-5, Table 10-8). A list of species recorded within the monitoring site is provided in Appendix 1.

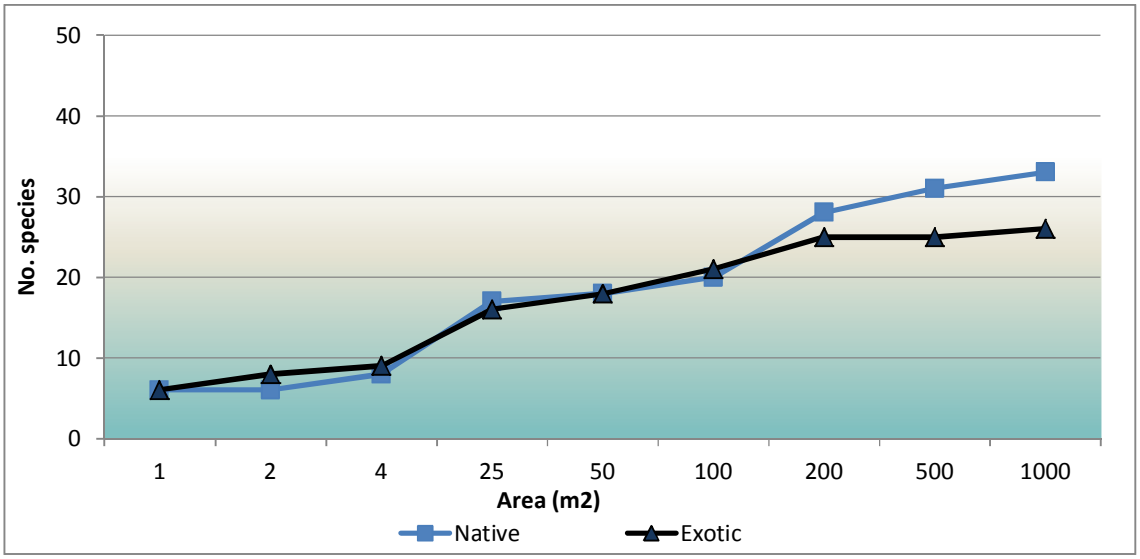


Figure 10-5. Cumulative species in the 50m x 20m (1000m²) monitoring quadrat.

Table 10-8. Cumulative species diversity.

Area (m2)	1	2	4	25	50	100	200	500	1000
Native	6	6	8	17	18	20	28	31	33
Exotic	6	8	9	16	18	21	25	25	26

10.1.9 Growth forms

Figure 10-6 is a summary of species in each growth form that were recorded in EOA-01. Herbs continued to be the most dominant plant type with 33 species including 21 exotic species. There was an increase to 20 grass species which included 5 exotic species, two native sub-shrubs and three reed species and there continued to be one native tree species. No shrubs or fern representatives were found. Compared to the woodland reference sites, there was two tree species too few.

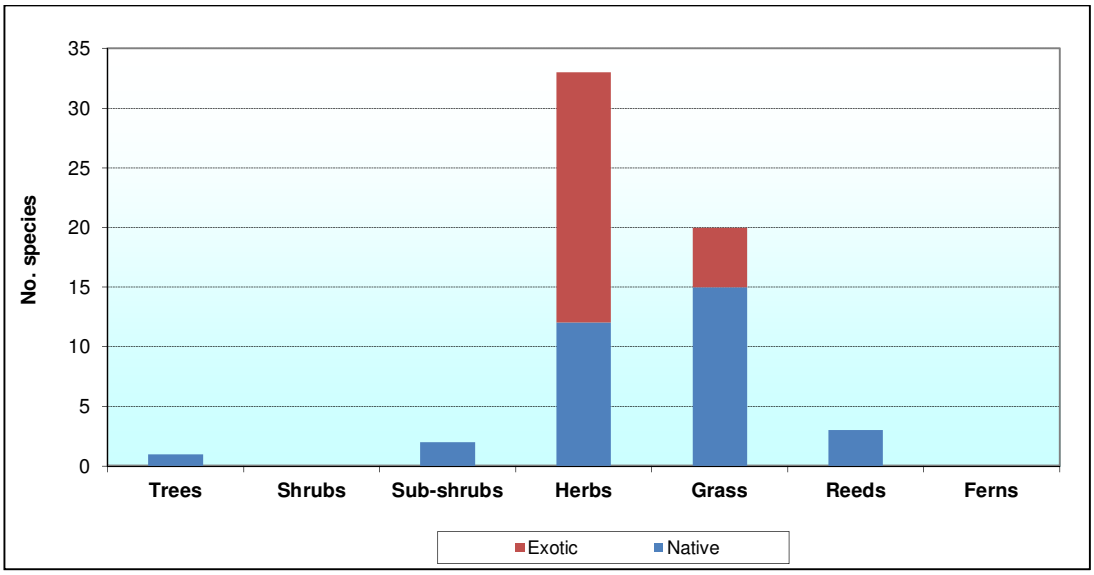


Figure 10-6. Graph illustrating the growth forms of species recorded in the 50m x 20m monitoring quadrat.

10.1.10 Comparison of rehabilitation data with key performance indicators

Table 10-9 indicates the performance of the monitoring site against the Completion and Desirable Performance Indicators developed for woodland sites during the 2012 monitoring period. The selection of criteria have been presented in order of ecosystem successional processes, beginning with landform establishment (orange) for example and ending with indicators of ecological stability (blue). The range values will be amended annually.

Rehabilitation sites meeting or exceeding the range values of their representative community type have identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 10-9. Comparison of key performance Indicators recorded in the offset site EOA-01 compared to lower and upper limits recorded in the woodland reference sites.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
Performance indicators are quantified by the range of values obtained from replicated reference sites							Lower	Upper	2010	2011	2012
Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope		Landform is generally compatible within the context of the local topography.	< Degrees (18°)	0	5	1	1	1
	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation		%	63.5	71.0	77.5	78.5	75.5
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation		%	44.4	52.8	43.3	44.5	42.3
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation		%	40.9	51.6	44.6	47.4	42.7
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation		%	100	100	100	100	100
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising		No.	0	0	0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0
Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	6.5	6.9	6.13	6.22	6.22
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.055	0.077	0.069	0.078	0.067
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	4.3	6.3	3.8	3.8	3.3
			Phosphorous		Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (50)	14.5	23.6	42.3	49.9	60.2
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (>12.5)	2.7	7.3	2.0	1.5	2.2
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	14.08	19.06	11.90	10.83	11.42
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	0.16	1.74	3.59	3.57	3.49
Ecosystem establishment	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	1	6	0	1	1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	na	100	100
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	44	60	57	58	59
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	39	44	34	31	33
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<No./area	3	18	23	27	26

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	**30**	**134**	0	1	**7**
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**2**	**4**	0	1	**1**
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**0**	**3**	0	0	**0**
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**1**	**7**	2	2	**2**
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**19**	**41**	39	38	**33**
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**10**	**18**	15	14	**20**
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	1	3	**3**
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**0**	0	0	**0**
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	0	0	**0**
Ecosystem development and habitat complexity	**Protective ground cover**	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	**62**	**77**	28.5	43.5	**56**
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	**0**	**1**	32	45.5	**36**
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	**0**	**8**	9	0.0	**0**
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	**0**	**0**	0	0.0	**0**
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	**0**	**2**	0.0	0.0	**0.5**
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	**2**	**14**	0	0.0	**0.5**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	9	36	30.5	11	7
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	87	99	100	100	99.5
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m^2	4	6	9	7.6	5.6
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	0	1	7.2	9	9
		Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	88	96	55.9	37.5	38.6
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	5	48	0.0	1	7
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	17	0.0	0	0
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	20	0.0	0	0
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	19	0.0	0	0
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	51	0.0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
Ecological stability	**Ecosystem structure**	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**0**	**8**	0	11.5	**0**
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**0**	**7**	0	0	**0**
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**3**	**15**	0	0	**0**
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**15**	**44**	0	0	**0**
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	**3**	**3**	0	0	**0**
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	**100**	**100**	0	0	**0**
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density		The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation	No./area	**6**	**19**	0	0	**0**
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	**18**	**54**	0	0	**0**
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	**83**	**100**	0	0	**0**
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	**0**	**42**	0	0	**0**
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	**50**	**80**	0	0	**0**
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	**0**	**22**	0	0	**0**
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	**0**	**17**	0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-01		
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	**0**	**0**	0	0	**0**
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	**47**	**89**	0	0	**0**

10.2 EOA-02 site description

EOA-02 was a derived grassland situated to the southeast of the Estcourt Offset Area. The site was an old cropping paddock that had not been recently grazed however stray stock had left hoof prints in the mud in 2010.

In 2010 it also contained a diverse understorey of native and introduced species including *Dicondra repens*, *Eragrostis parviflora* and *Medicago polymorpha*. There was a relatively high floristic diversity (48 species) and native species (26) were more abundant than exotic species (22). There was generally good ground cover with annual species dominating 50% of the site. There was 29% cover provided by perennial plants and cryptogams were moderately abundant in the southern end of the transect. There were scattered occurrences of *Carthamus lanatus, Echium plantagineum* and *Arctotheca calendula.* In 2011, it was similar to EOA-01 with increased levels of ground over, decreased abundance of cryptogams but maintained a high diversity of native and exotic species. Weeds were less abundant. In 2012 the site was similar to but drier than last year and 24 *C. glaucophylla* seedlings were found.

10.2.1 Landscape Function Analysis

10.2.1.1 Landscape organisation

EOA-02 continued to be characterised as a grassland patch and with excellent ground cover scored a Landscape Organisation Index of 1.0 or was 100% capable of harnessing mobile resources (Figure 10-7, Table 10-10). Between 2010 and 2011 there was a marginal improvement in ecological function largely due to increased levels of litter cover which have begun to accumulate some depth across most of the site and slightly increased soil surface relief. In 2012 however there was slight decline in ecological function due to less cover of perennial plants and increased soil surface hardness.

The resultant LFA indices for stability, infiltration and nutrient recycling were 74.5, 40.7 and 42.3 respectively. While all LFA related targets were met last year, stability and nutrient recycling indices were 11 and 1.4 LFA units higher than the minimum target range but infiltration was 3.7 LFA units lower.

Figure 10-7. Permanent photo point taken from the top of the LFA transect in 2011 (left) and 2012 (right).

Table 10-10. Summary of landscape organisation and LFA indices in 2010, 2011 and 2012.

EOA-02		24/9/2010		20/10/2011		18/10/2012	
Number of Patches/10m		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		NA		NA	
Range Interpatch length (m)		NA		NA		NA	
Patch or Interpatch Type		**Grassland Patch**		**Grassland Patch**		**Grassland Patch**	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment							
Within Individual Zones	**Stability**	71.0		73.5		74.5	
	Infiltration	41.5		45.4		40.7	
	Nutrients	40.9		42.7		42.3	
			Total		**Total**		**Total**
Individual zones contribution to the whole of Landscape	**Stability**	71.0	**71.0**	73.5	**73.5**	74.5	**74.5**
	Infiltration	41.5	**41.5**	45.4	**45.4**	40.7	**40.7**
	Nutrients	40.9	**40.9**	42.7	**42.7**	42.3	**42.3**

10.2.1.2 Soil Surface Assessment

There was a decline in cover provided by perennial plants which subsequently resulted in a decline in protection from rain splash and a lower basal area cover (Table 10-11). There was a slight increase in annual plant and dead litter cover which continued to provide high levels of cover across the entire site and has accumulated to some depth across most of the site. There continued to be slight rates of litter decomposition observed across the site which is a particularly important attribute in terms of nutrient recycling and indicates a presence of microbial and fungal activity. The soil surface continued to be crusted and cryptogams were in slightly higher abundance and more frequent than last year. The scattered grass tussocks continued to provide moderate soil surface relief and due to the good ground cover, there was little to no evidence of erosion or deposition despite the heavy rainfall which occurred over the summer period. The clay loam soils had increased surface hardness and this year they were very hard to penetrate but they remained very stable.

Table 10-11 . Results of the Soils Surface Assessment for the Grassland patch.

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Soil Cover	5	2	1	4	1	2
Per. basal / canopy cover	4	2	1	2	1	2
Litter cover, orig & incorp.	10	6ls	6ls	6ls	6ls	5ls
Cryptogam cover	4	1	2	2	3	2
Crust broken-ness	4	4	4	4	4	4
Erosion type & severity	4	4	4	4	4	4
Deposited materials	4	4	4	4	4	4
Soil surface roughness	5	3	3	3	3	3
Surface resist. to disturb.	5	4	4	4	4	4
Slake test	4	4	4	4	4	4
Texture	4	2	2	2	2	2

10.2.2 Soil analyses

There has been little changes in the soil characteristics since 2010 and in all cases any change has been relatively insignificant. The soils remained slightly acidic and while they were slightly lower than the reference sites they continued to fall within the desirable levels prescribed by the agricultural industry (Table 10-12). The Electrical Conductivity was slightly higher and this year slightly exceeded local levels but remained well below desirable levels. Organic Matter content, Nitrate and CEC levels were low. There has been a slight decrease in Phosphorous levels but they continued to be higher than local woodland areas as a result of the previous cultivation history but they remained lower than desirable levels. There was a slight increase in the Exchangeable Sodium Percentage (ESP) which remained higher than the reference sites but well below the desirable level of 5% indicating that the soils are non sodic.

Table 10-12. Results of the soil analysis for EOA-02 compared to the upper and lower values for the woodland reference sites and desirable levels 2010 - 2012.

Nutrient	Units	EOA-02			Lower KPI	Upper KPI	*Desirable Level*
		2010	**2011**	**2012**			
pH (1:5 water)	units	6.17	6.11	6.24	6.48	6.87	*5.6 – 7.3*
Conductivity (1:5 water)	dS/m	0.032	0.070	0.094	0.05	0.08	*0.150*
Organic Matter	%	3.7	3.7	3.9	4.31	6.34	*>4.5*
Phosphorus (Colwell)	mg/kg	54	49	44	14.46	23.62	*50*
Nitrate	mg/kg	1.6	2.2	2.3	2.68	7.32	*13.0*
Cation Exchange Capacity	$cmol^+/Kg$	11.56	10.70	11.43	14.08	19.06	*14.00*
Exchangeable Sodium Percentage	%	1.93	1.99	2.83	0.16	1.74	<5

10.2.3 Rill assessment

No rills were observed within the monitoring quadrat in any monitoring year.

10.2.4 Tree density and health condition

No trees were present within this monitoring plot.

10.2.5 Shrubs and regeneration

There has been a significant regeneration event in 2012 with 24 *Callitris glaucophylla* seedlings observed for the first time within the 50 x 20m monitoring plot (Table 10-13). At the time of monitoring all seedlings were approximately 5-10cm tall. Many other juvenile *C. glaucophylla, E. microcarpa* and *E. populnea* were now visible within the larger paddock areas a result of natural recruitment stimulated by the good summer rainfall over the past two years.

Table 10-13. Shrubs and young trees occurring within the monitoring site.

Species	0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	>2.0m	Total	endemic	not endemic
Callitris glaucophylla	24					**24**	24	
Total	**24**	**0**	**0**	**0**	**0**	**24**	**24**	**0**
% endemic species							**100**	**0**

10.2.6 Structural diversity and habitat complexity

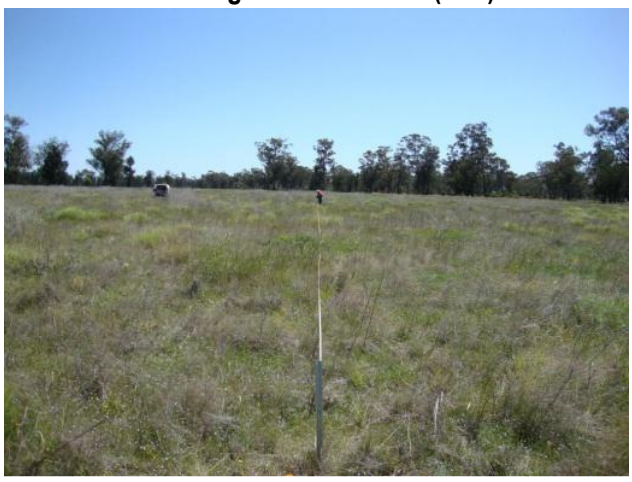
There has been very little change in the overall structure of this recovering native grassland which remains devoid of a shrub and canopy layer (Figure 10-8). This year there continued to be 100% total ground cover but there has been a decrease from 49.5 – 20.0% perennial plant cover due to the dry spring weather conditions. Subsequently there has been an increase in dead litter cover which provided 52.5% cover this year. Annual plant cover has remained relatively consistent and provides an average of 27.5% ground cover this year (Figure 10-9). No cryptogams were recorded along the transect and this year some of the taller grass tussocks provided 7.5% foliage cover greater than 0.5m in height. Table 10-14 provides the average and minimum and maximum values obtained along the vegetation transect in 2012.

2010 Vegetation transect (front)

2010 Vegetation transect (rear)

2011 Vegetation transect (front)

2011 Vegetation transect (rear)



2012 Vegetation transect (front) **2012 Vegetation transect (rear)**

Figure 10-8. Permanent photo points taken from the front (left) and rear (right) of the vegetation transect.

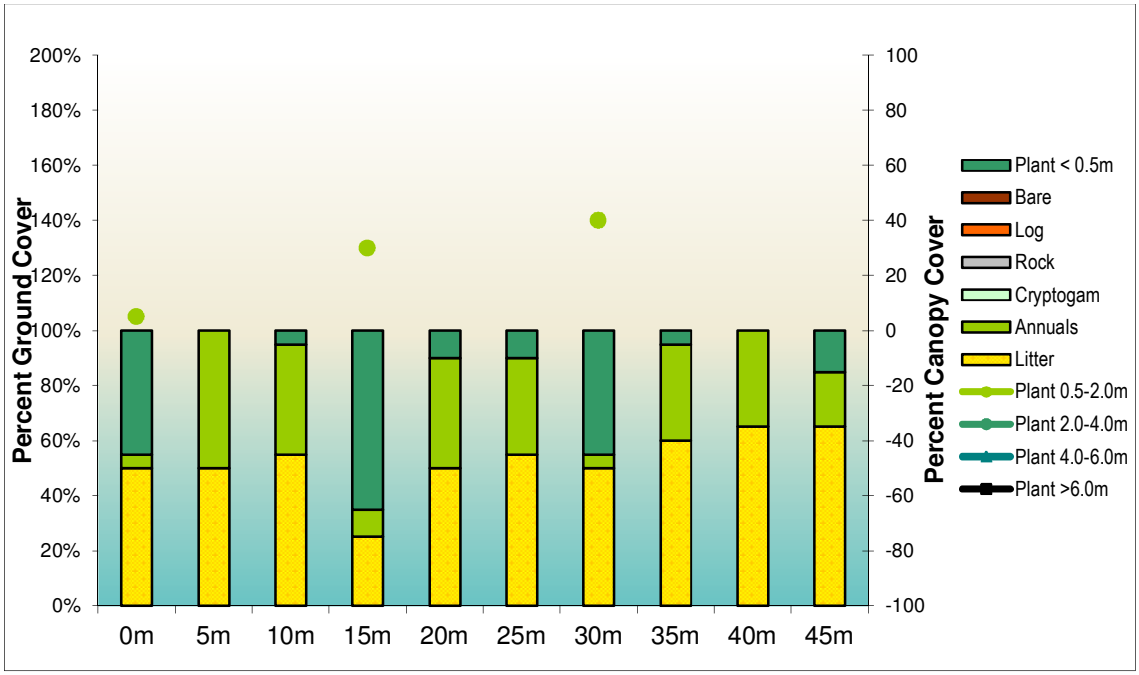


Figure 10-9. Graph illustrating the structural diversity and habitat complexity of the monitoring site.

Table 10-14. Average and minimum and maximum values of the structural diversity of the monitoring site.

Vegetation structure	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m	Average	Min	Max
Litter	50	50	55	25	50	55	50	60	65	65	**52.5**	**25**	**65**
Annuals	5	50	40	10	40	35	5	35	35	20	**27.5**	**5**	**50**
Cryptogam	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Rock	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Log	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Bare	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Perennial <0.5m	45	0	5	65	10	10	45	5	0	15	**20**	**0**	**65**
Total Ground Cover	100	100	100	100	100	100	100	100	100	100	**100**	**100**	**100**
0.5-2.0m	5	0	0	30	0	0	40	0	0	0	**7.5**	**0**	**40**
2.0-4.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
4.0-6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
>6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**

10.2.7 Species cover abundance

In 2012 a total of 22 different species were recorded in the five 1m^2 quadrats on the permanent vegetation transect line which was two less than was recorded in 2011. Twelve of the species were exotic. Using the Braun-blanquet scale, the highest possible cover score that can be obtained is 30 and cover abundance is illustrated as a sum of scores (class values) obtained along the five 1m^2 quadrats.

This year most ground cover was provided by the native forb *Wahlenbergia gracilis* and the exotic annuals *Trifolium subterranean, Medicago truncatula, Lactuca saligna* and *Bromus molliformis* (Figure 10-10, Table 10-15). There has been a significant reduction in cover provided by *Trifolium* species and *Dicondra repens*. The native grasses *Chloris truncata, Enteropogon acicularis* and *Walwhalleya proluta* were present but were infrequent and provided low cover scores. The remaining species were less common with many being recorded on only one occasion and/or provided low cover values. Of the live plant cover scores recorded 33.3% was provided by native species.

Table 10-15. List of species and their average cover abundance score across the five, 1m^2 monitoring quadrats.

Species	0m	10m	20m	30m	40m	Total
**Avena fatua*					1	1
**Bromus molliformis*	1	2	2	2	1	8
**Echium plantagineum*		1				1
**Lactuca saligna*	2	4	1	1	1	9
**Lolium rigidum*	1		1	2	1	5
**Medicago polymorpha*	3					3
**Medicago truncatula*	3	1	2	3	2	11
**Trifolium angustifolium*		4				4
**Trifolium campestre*	2			1		3
**Trifolium glomeratum*	3	4				7
**Trifolium subterraneum*			4	3	5	12
**Vulpia sp.*	1	2	1			4
Austrostipa scabra subsp. scabra	1					1
Carex inversa				2	1	3
Chloris truncata	2			3		5
Dichondra repens				1	2	3
Einadia nutans subsp. nutans				1		1
Enteropogon acicularis				1		1
Juncus usitatus		1		1		2
Sclerolaena muricata	1		1			2
Wahlenbergia gracilis	3	1	2	3	3	12
Walwhalleya proluta	3			1		4
Total cover						102
Sum of cover of native species						34
Percent endemic species cover						**33.3**

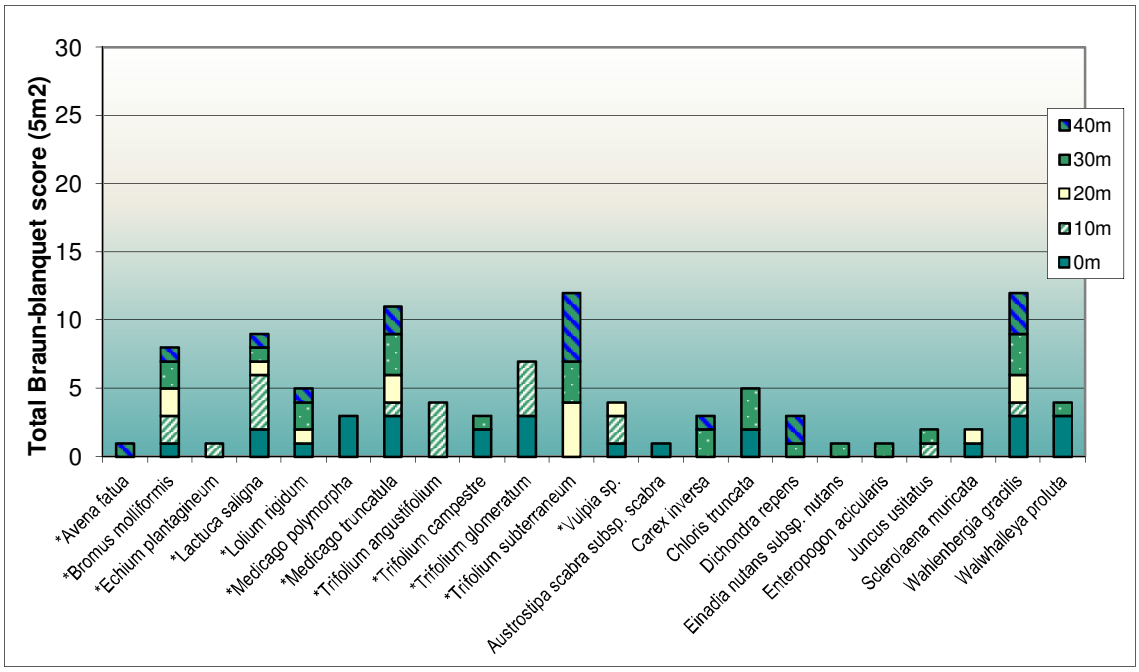


Figure 10-10. Total species recorded across the five, 1m² quadrats using the Braun-blanquet scale (max possible score is 30) as a measure of cover abundance.

10.2.8 Floristic diversity

The floristic diversity of the sites was measured using two different methods. One provides an assessment of the average number of species within five, one square metre (m^2) sub-quadrats along the vegetation transect, while the other provides the total number of species within the entire 50x20m monitoring plot.

10.2.8.1 Species diversity per m²

With the drier season compared to the previous monitoring years there were fewer native and exotic species on average within the five replicates sub-plots. Natives have declined from 4.6 - 4.0 native species and 6.8 - 6.6 exotic species per m^2 since 2011 (Table 10-16). The number of native species ranged between 2 – 8 species per m^2, while the number of exotic species ranged between 6 – 8 species per m^2.

Table 10-16. Species diversity per 1m².

Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	5	2	2	8	3	**4**	2.5
Exotic	8	7	6	6	6	**6.6**	0.9
Total	**13**	**9**	**8**	**14**	**9**	**10.6**	2.7

10.2.8.2 Total species diversity

There has however been an increase in the total floristic diversity over the past year. There were five more native species that provided a total of 25 native and 19 exotic species, which remained constant, in the 50 x 20m monitoring quadrat (Figure 10-11, Table 10-17). A full list of species recorded within the monitoring site is provided in Appendix 1.

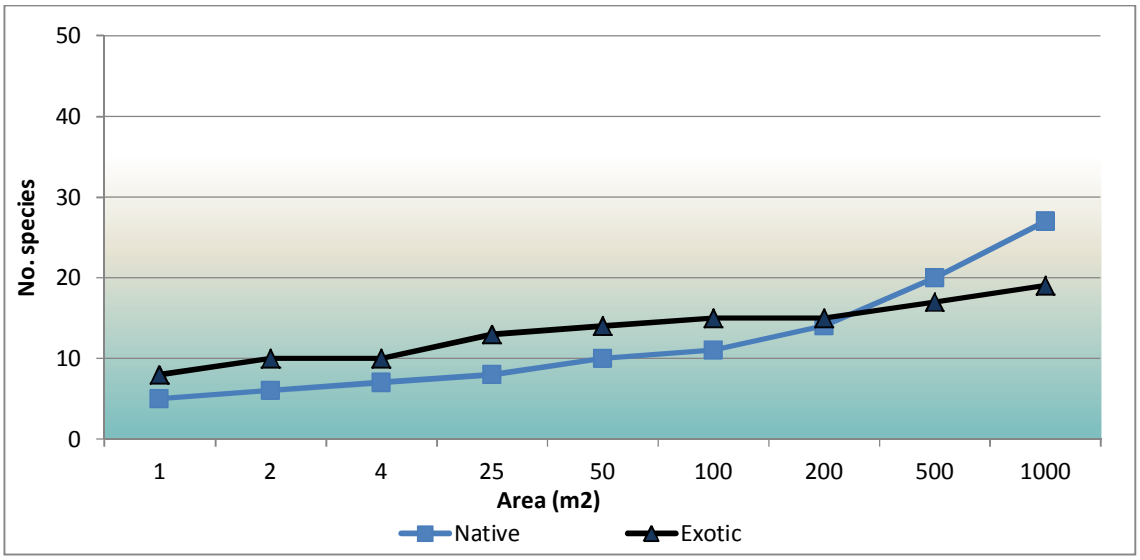


Figure 10-11. Cumulative species in the 50m x 20m (1000m²) monitoring quadrat.

Table 10-17. Cumulative species diversity.

Area (m2)	1	2	4	25	50	100	200	500	1000
Native	5	6	7	8	10	11	14	20	27
Exotic	8	10	10	13	14	15	15	17	19

10.2.9 Growth forms

Figure 10-12 is a summary of species in each growth form that were recorded in EOA-02. Herbs continued to be the most dominant plant type with 25 species including 14 exotic species. There was a large increase in the number of grasses which has increased from nine to 15 different species and this included five exotic species. There were three native sub-shrubs and two species of reed and this year there was one tree species. No shrub or fern representatives were recorded. Compared to the composition of the reference sites this site lacked two tree species.

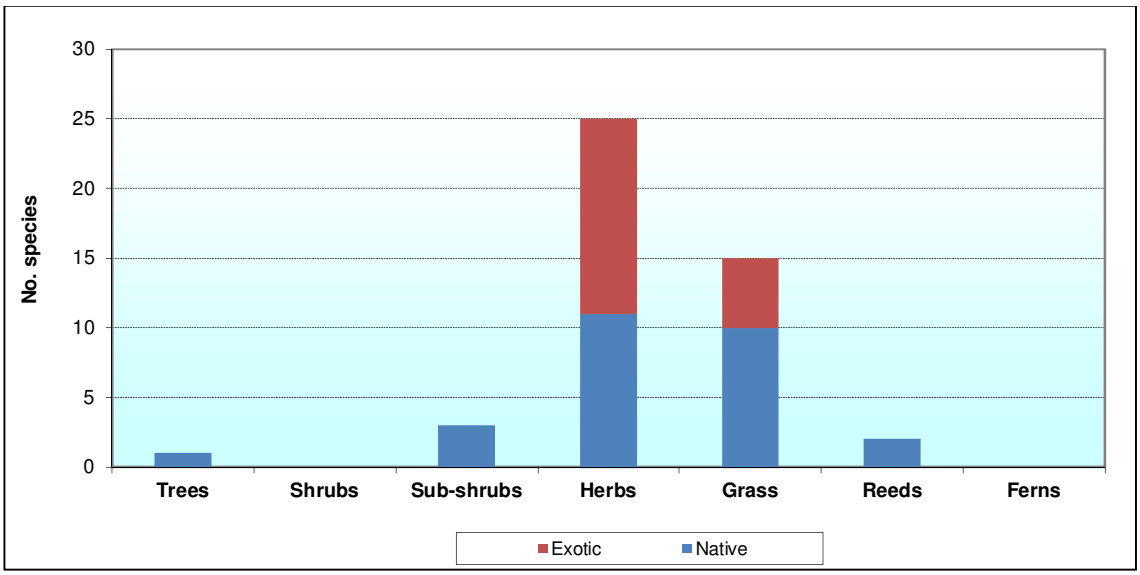


Figure 10-12. Graph illustrating the growth forms of species recorded in the 50m x 20m monitoring quadrat.

10.2.10 Comparison of rehabilitation data with key performance indicators

Table 10-18 indicates the performance of the monitoring site against the Completion and Desirable Performance Indicators developed for woodland sites during the 2012 monitoring period. The selection of criteria have been presented in order of ecosystem successional processes, beginning with landform establishment (orange) for example and ending with indicators of ecological stability (blue). The range values will be amended annually.

Rehabilitation sites meeting or exceeding the range values of their representative community type have identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 10-18. Comparison of key performance Indicators recorded at site EOA-02 compared to lower and upper limits recorded in the woodland reference sites.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
Performance indicators are quantified by the range of values obtained from replicated reference sites							Lower	Upper	2010	2011	2012
Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope		Landform is generally compatible within the context of the local topography.	< Degrees (18°)	0	5	1	1	1
	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation		%	63.5	71.0	71.0	73.5	74.5
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation		%	44.4	52.8	41.5	45.4	40.7
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation		%	40.9	51.6	40.9	42.7	42.3
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation		%	100	100	100	100	100
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising		No.	0	0	0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0
Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	6.5	6.9	6.17	6.11	6.24
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.055	0.077	0.032	0.070	0.094
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	4.3	6.3	3.7	3.7	3.9
			Phosphorous		Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (50)	14.5	23.6	54.1	48.5	44.3
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (>12.5)	2.7	7.3	1.6	2.2	2.3
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	14.08	19.06	11.56	10.70	11.43
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	0.16	1.74	1.93	1.99	2.83
Ecosystem establishment	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	1	6	0	0	1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	na	NA	100
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	44	60	48	41	46
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	39	44	26	22	27
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<No./area	3	18	22	19	19

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	**30**	**134**	0	0	**24**
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**2**	**4**	0	0	**1**
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**0**	**3**	0	0	**0**
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**1**	**7**	1	4	**3**
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**19**	**41**	36	26	**25**
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**10**	**18**	10	9	**15**
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	1	2	**2**
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**0**	0	0	**0**
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	0	0	**0**
Ecosystem development and habitat complexity	**Protective ground cover**	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	**62**	**77**	14.5	26.5	**52.5**
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	**0**	**1**	50.0	24.0	**27.5**
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	**0**	**8**	4.5	0.0	**0**
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	**0**	**0**	0	0.0	**0**
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	**0**	**2**	0.0	0.0	**0**
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	**2**	**14**	2	0.0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	9	36	29	49.5	**20**
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	87	99	98	100	**100**
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m^2	4	6	8.4	4.6	**4**
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	0	1	8.4	6.8	**6.6**
		Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	88	96	54.2	34.7	**33.3**
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	5	48	0.0	0	**24**
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	17	0.0	0	**0**
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	20	0.0	0	**0**
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	19	0.0	0	**0**
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	51	0.0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
Ecological stability	**Ecosystem structure**	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**0**	**8**	0	1	**7.5**
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**0**	**7**	0	0	**0**
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**3**	**15**	0	0	**0**
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**15**	**44**	0	0	**0**
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	**3**	**3**	0	0	**0**
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	**100**	**100**	0	0	**0**
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density		The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation	No./area	**6**	**19**	0	0	**0**
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	**18**	**54**	0	0	**0**
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	**83**	**100**	0	0	**0**
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	**0**	**42**	0	0	**0**
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	**50**	**80**	0	0	**0**
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	**0**	**22**	0	0	**0**
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	**0**	**17**	0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-02		
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	**0**	**0**	0	0	**0**
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	**47**	**89**	0	0	**0**

10.3 EOA-03 site description

EOA-03 was an open grassy clearing situated in the centre of the southern woodland area on top of the hill. It was dominated by native grasses particularly *Austrostipa scabra subsp. falcata* and contained a very high diversity of native (43) and introduced species (18) including many Asteraceae and Poaceae species. There was good ground cover provided by perennial plants (59%) and annual 30%) and there was small quantities of cover provided by leaf litter and cryptogams. There were sparse occurrences of *Carthamus lanatus, Echium plantagineum, Salvia verbenaca, Erodium cicutarium* and a variety of *Medicago* and *Trifolium species.* On the fringing woodland (photo point 2 GHD 2010), there was a diverse range of additional native species including *Arthropodium minus, Stackhousia monogyna, Pterostylis sp, Dicopogon stricta, Bulbine bulbosa, Goodenia pinnatifida* and *Calotis cuneifolia* to name a few. In 2011 and 2012 the site was very dry with macropod grazing maintaining low grass cover. There was a significant decline in floral diversity but the site retained good ground cover. In 2012 seven *C. glaucophylla* seedlings were found within the site.

10.3.1 Landscape Function Analysis

10.3.1.1 Landscape organisation

EOA-03 continued to be characterised as a grassland patch and with excellent ground cover scored a Landscape Organisation Index of 1.0 or was 100% capable of harnessing mobile resources (Figure 10-13, Table 10-19). There has been a marginal decline in the stability of the site due to a reduction in perennial plant cover and loss of cryptogams but marginal increases were observed in infiltration and nutrient recycling capacity due to a significant improvement in litter decomposition and this year moderate decomposition was observed across the site.

The resultant LFA indices for stability, infiltration and nutrient recycling were 73.0, 52.0 and 49.6 respectively. Compared to the minimum range provided by the woodland reference sites this site was 9.5, 7.6 and 8.7 LFA units higher.

Figure 10-13. Permanent photo point taken from the top of the LFA transect in 2011 (left) and 2012 (right).

Table 10-19. Summary of landscape organisation and LFA indices in 2010, 2011 and 2012.

EOA-03		24/9/2010		20/10/2011		18/10/2012	
Number of Patches/10m		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		NA		NA	
Range Interpatch length (m)		NA		NA		NA	
Patch or Interpatch Type		Grassland Patch		Grassland Patch		Grassland Patch	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment							
Within Individual Zones	Stability	77.5		77.5		73.0	
	Infiltration	45.4		51.7		52.0	
	Nutrients	43.7		48.8		49.6	
			Total		Total		Total
Individual zones contribution to the whole of Landscape	Stability	77.5	**77.5**	77.5	**77.5**	73.0	**73.0**
	Infiltration	45.4	**45.4**	51.7	**51.7**	52.0	**52.0**
	Nutrients	43.7	**43.7**	48.8	**48.8**	49.6	**49.6**

10.3.1.2 Soil Surface Assessment

In the grassland patch, there was a decline in perennial plant cover and as a result there was a lower level of rain splash protection and perennial basal cover (Table 10-20). The level of litter cover remained high and had accumulated to some depth and this year moderate decomposition was now observed across all replicates within the site indicating a positive increase in microbial and fungal activity. The soil surface remained crusted but due to the increase in vegetative cover there has been a further decline in cryptogams and none were observed in any replicates. The grass tussocks continued to provide moderate to high soil surface relief and there little to no evidence of erosion or decomposition. The loam soils continued to be moderately hard and very stable.

Table 10-20 . Results of the Soils Surface Assessment for the Grassland patch.

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Soil Cover	5	3	4	3	3	3
Per. basal / canopy cover	4	3	3	3	3	3
Litter cover, orig & incorp.	10	6lm	6lm	6lm	6lm	6ls
Cryptogam cover	4	1	1	1	1	1
Crust broken-ness	4	4	4	4	4	4
Erosion type & severity	4	4	4	4	4	4
Deposited materials	4	4	4	4	4	4
Soil surface roughness	5	3	4	3	3	2
Surface resist. to disturb.	5	3	3	3	3	3
Slake test	4	4	4	4	4	4
Texture	4	2	2	2	2	2

10.3.2 Soil analyses

There have been little changes in the soil characteristics since 2010 and in all cases any change has been relatively insignificant. The soils remained slightly acidic and while they were slightly lower than the reference sites they continued to fall within the desirable levels prescribed by the agricultural industry (Table 10-21). The Electrical Conductivity, Organic Matter, Phosphorous and Nitrate levels continued to fall within local levels. The soils continued to have a low CEC and Exchangeable Sodium Percentage indicating the soils are non sodic.

Table 10-21. Results of the soil analysis for EOA-03 compared to the upper and lower values for the woodland reference sites and desirable levels in 2010, 2011 and 2012.

Nutrient	Units	EOA-03			Lower KPI	Upper KPI	*Desirable Level*
		2010	**2011**	**2012**			
pH (1:5 water)	units	5.68	6.22	6.40	6.48	6.87	*5.6 – 7.3*
Conductivity (1:5 water)	dS/m	0.176	0.075	0.070	0.05	0.08	*0.150*
Organic Matter	%	5.5	6.3	5.2	4.31	6.34	*>4.5*
Phosphorus (Colwell)	mg/kg	23	16	15	14.46	23.62	*50*
Nitrate	mg/kg	42.1	2.2	3.8	2.68	7.32	*13.0*
Cation Exchange Capacity	$cmol^+/Kg$	10.74	11.90	11.14	14.08	19.06	*14.00*
Exchangeable Sodium Percentage	%	0.92	0.32	0.38	0.16	1.74	<5

10.3.3 Rill assessment

No rills were observed within the monitoring quadrat in any monitoring year.

10.3.4 Tree density and health condition

No trees or shrubs with a dbh >5cm were present within this monitoring plot.

10.3.5 Shrubs and regeneration

In 2012, seven *Callitris glaucophylla* seedlings counted for the first time within the 50 x 20m monitoring plot as a result of natural recruitment stimulated by the high rainfall activity over the last two summers (Table 10-22). At the time of monitoring all seedlings were approximately 5-10cm tall. Many other juvenile *C. glaucophylla, E. microcarpa* and *E. populnea* were regenerating within the clearings as a result of natural recruitment stimulated by the good summer rainfall over the past two years.

Table 10-22. Shrubs and young trees occurring within the monitoring site.

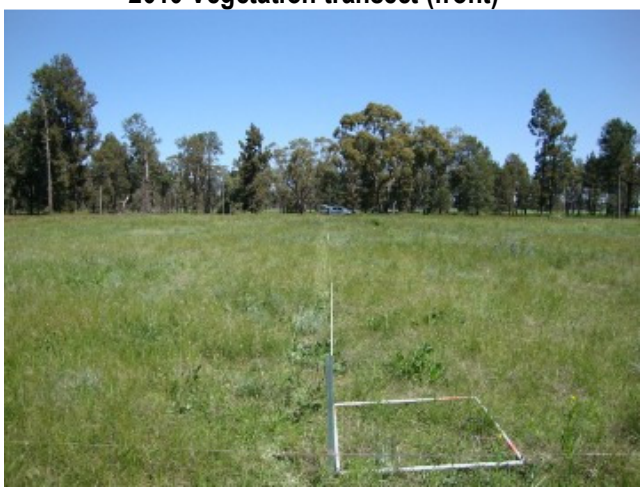
Species	0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	>2.0m	Total	endemic	not endemic
Callitris glaucophylla	7					**7**	7	
Total	**7**	**0**	**0**	**0**	**0**	**7**	**7**	**0**
% endemic species							**100**	**0**

10.3.6 Structural diversity and habitat complexity

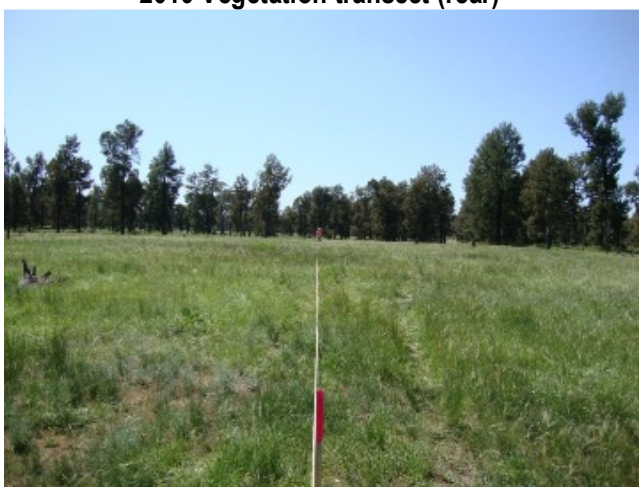
There has been very little change in the overall structure of this open grassy clearing which remains devoid of a shrub and canopy layer (Figure 10-14 and Figure 10-15). There continued to be 100% total

ground cover and this was dominated by dead leaf litter which provides 54.5% of the total ground cover. Due to the dry conditions there has been a decline in perennial annual plant covers which now provided 43.5 and 2% respectively. There continued to be an absence of cryptogams due to the high ground cover. The dry conditions combined with macropod grazing have maintained a low grass cover and no foliage cover greater than 0.5m in height was recorded. Table 10-5 provides the average and minimum and maximum values obtained along the vegetation transect.

2010 Vegetation transect (front)



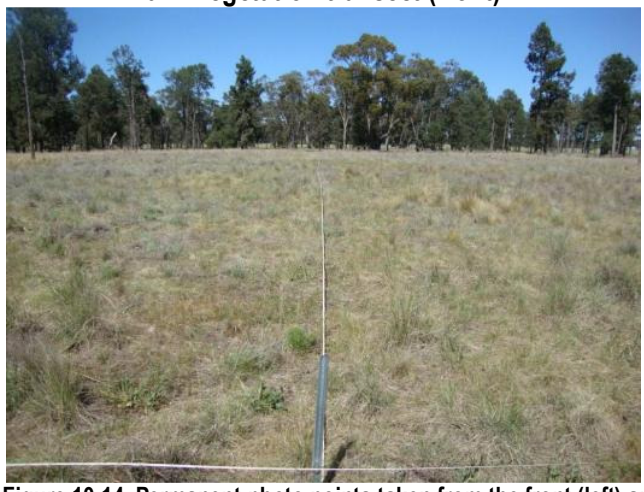
2010 Vegetation transect (rear)



2011 Vegetation transect (front)

2011 Vegetation transect (rear)

2012 Vegetation transect (front)



2012 Vegetation transect (rear)

Figure 10-14. Permanent photo points taken from the front (left) and rear (right) of the vegetation transect.

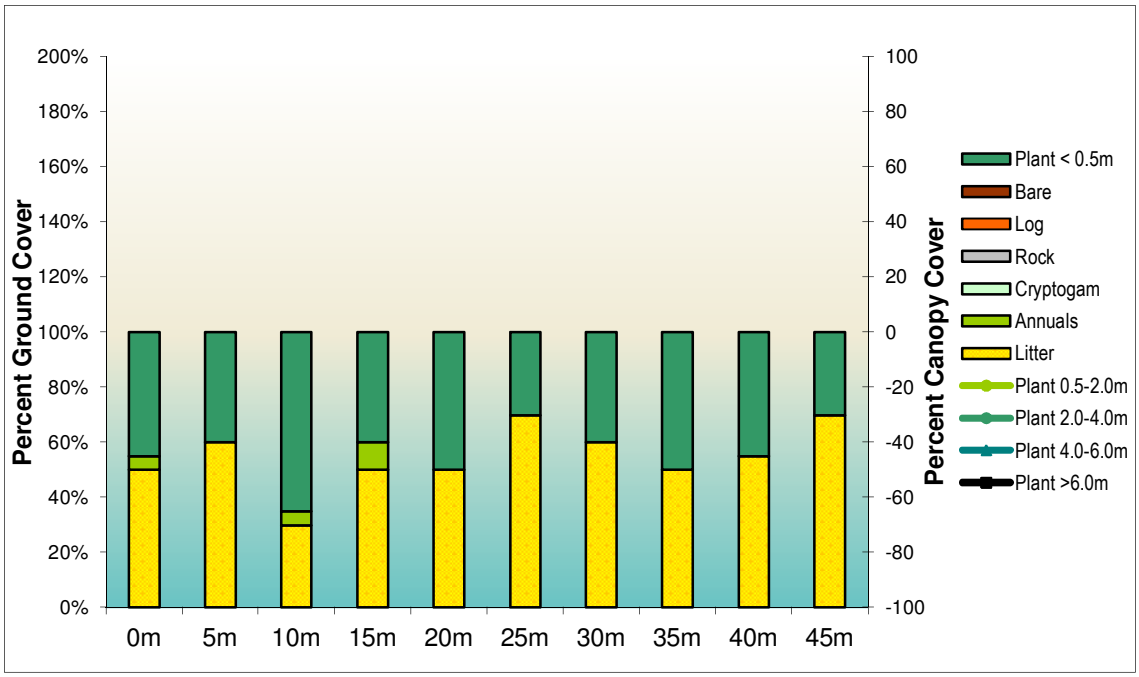


Figure 10-15. Graph illustrating the structural diversity and habitat complexity of the monitoring site.

Table 10-23. Average and minimum and maximum values of the structural diversity of the monitoring site.

Vegetation structure	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m	Average	Min	Max
Litter	50	60	30	50	50	70	60	50	55	70	**54.5**	**30**	**70**
Annuals	5	0	5	10	0	0	0	0	0	0	**2**	**0**	**10**
Cryptogam	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Rock	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Log	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Bare	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Perennial <0.5m	45	40	65	40	50	30	40	50	45	30	**43.5**	**30**	**65**
Total Ground Cover	100	100	100	100	100	100	100	100	100	100	**100**	**100**	**100**
0.5-2.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
2.0-4.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
4.0-6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
>6.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**

10.3.7 Species cover abundance

This year a total of 32 species, 10 of which were exotic species were found in the five 1m^2 quadrats on the permanent vegetation transect line. This was an increase from the 28 species in 2011 but remained less diverse than the 40 species observed in the first monitoring event in 2010. Using the Braun-blanquet scale, the highest possible cover score that can be obtained is 30 and cover abundance is illustrated as a sum of scores (class values) obtained along the five 1m^2 quadrats.

Figure 10-16 and Table 10-24 show that native species remained dominant within this site but in most cases all species were less abundant than in 2011. The most common and abundant species were *Vittadinia gracilis, Austrodanthonia eriantha, Elymus scaber, Austrostipa scabra subsp. falcata* and *Austrostipa bigeniculata.* Other common native species included *Sida corrugata* and *Wahlenbergia gracilis,* with the most common exotic species in 2012 being *Salvia verbenaca.* The remaining species were fewer in number and/or provided lower cover values. Of the live plant cover scores recorded 81.3% was provided by native species.

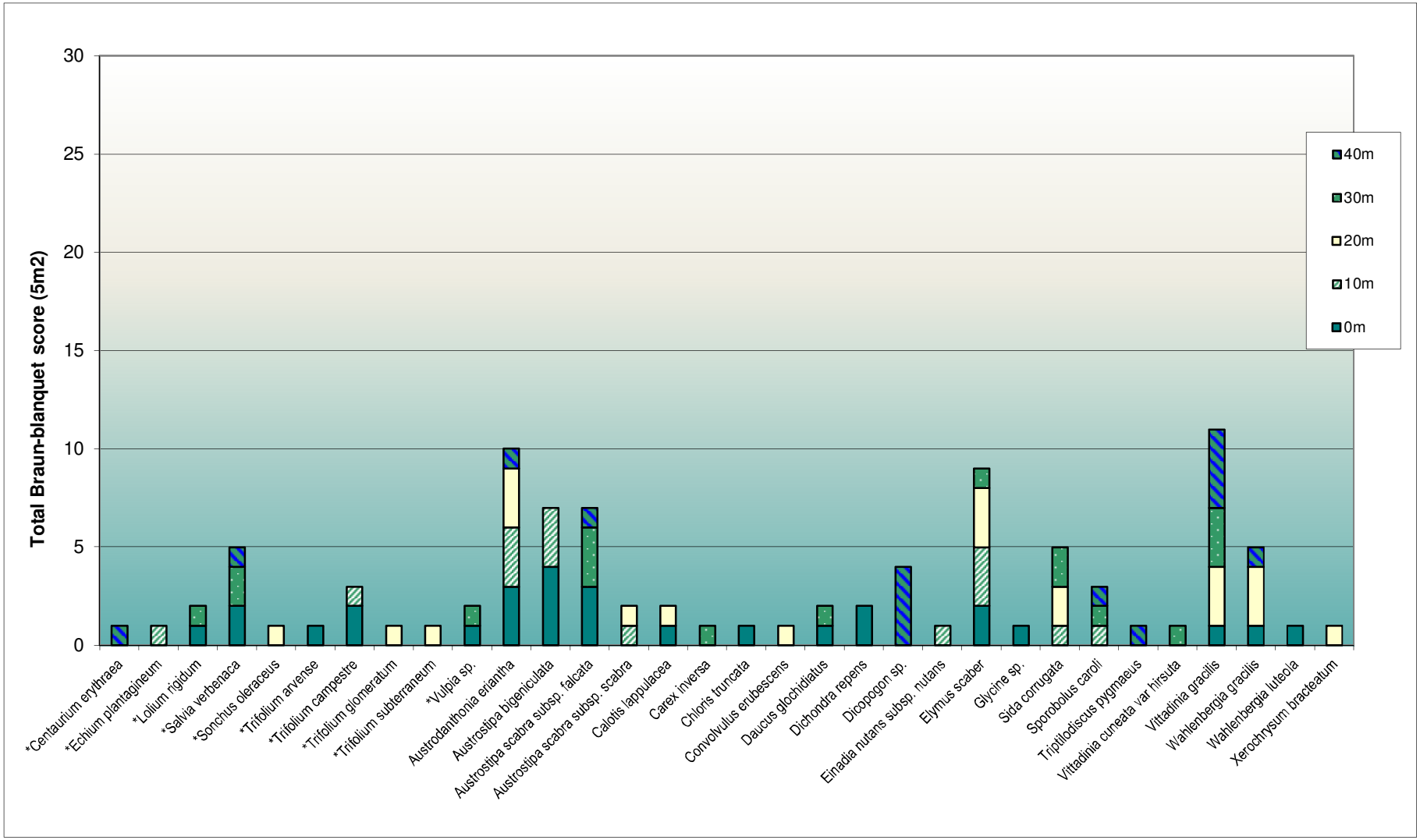


Figure 10-16. Total species recorded across the five, 1m² quadrats using the Braun-blanquet scale (max possible score is 30) as a measure of cover abundance.

Table 10-24. List of species and their average cover abundance score across the five, 1m² monitoring quadrats.

Species	0m	10m	20m	30m	40m	Total
**Centaurium erythraea*					1	1
**Echium plantagineum*		1				1
**Lolium rigidum*	1			1		2
**Salvia verbenaca*	2			2	1	5
**Sonchus oleraceus*			1			1
**Trifolium arvense*	1					1
**Trifolium campestre*	2	1				3
**Trifolium glomeratum*			1			1
**Trifolium subterraneum*			1			1
**Vulpia sp.*	1			1		2
Austrodanthonia eriantha	3	3	3		1	10
Austrostipa bigeniculata	4	3				7
Austrostipa scabra subsp. falcata	3			3	1	7
Austrostipa scabra subsp. scabra		1	1			2
Calotis lappulacea	1		1			2
Carex inversa				1		1
Chloris truncata	1					1
Convolvulus erubescens			1			1
Daucus glochidiatus	1			1		2
Dichondra repens	2					2
Dicopogon sp.					4	4
Einadia nutans subsp. nutans		1				1
Elymus scaber	2	3	3	1		9
Glycine sp.	1					1
Sida corrugata		1	2	2		5
Sporobolus caroli		1		1	1	3
Triptilodiscus pygmaeus					1	1
Vittadinia cuneata var hirsuta				1		1
Vittadinia gracilis	1		3	3	4	11
Wahlenbergia gracilis	1		3		1	5
Wahlenbergia luteola	1					1
Xerochrysum bracteatum			1			1
Total cover						96
Sum of cover of native species						78
Percent endemic species cover						**81.3**

10.3.8 Floristic diversity

The floristic diversity of the sites was measured using two different methods. One provides an assessment of the average number of species within five, one square metre (m²) sub-quadrats along the vegetation transect, while the other provides the total number of species within the entire 50x20m monitoring plot.

10.3.8.1 Species diversity per m²

There has been a further decline in the number of native species per m² this year which have declined from 10.2 to 8.6 species, while exotic species have increased slightly from 2.2 to 3.0 species per m² (Table 10-25). The number of native species ranged between 7 - 12 species per m², while the number of exotic species ranged between 2 – 5 species per m².

Table 10-25. Species diversity per 1m².

Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	12	7	9	8	7	**8.6**	2.1
Exotic	5	2	3	3	2	**3**	1.2
Total	**17**	**9**	**12**	**11**	**9**	**11.6**	3.3

10.3.8.2 Total species diversity

The overall total floristic diversity has further declined however this year there was only one less native species. This year there were 32 native and 17 exotic species recorded in the 50 x 20m monitoring quadrat (Figure 10-17, Table 10-26). A full list of species recorded within the monitoring site is provided in Appendix 1.

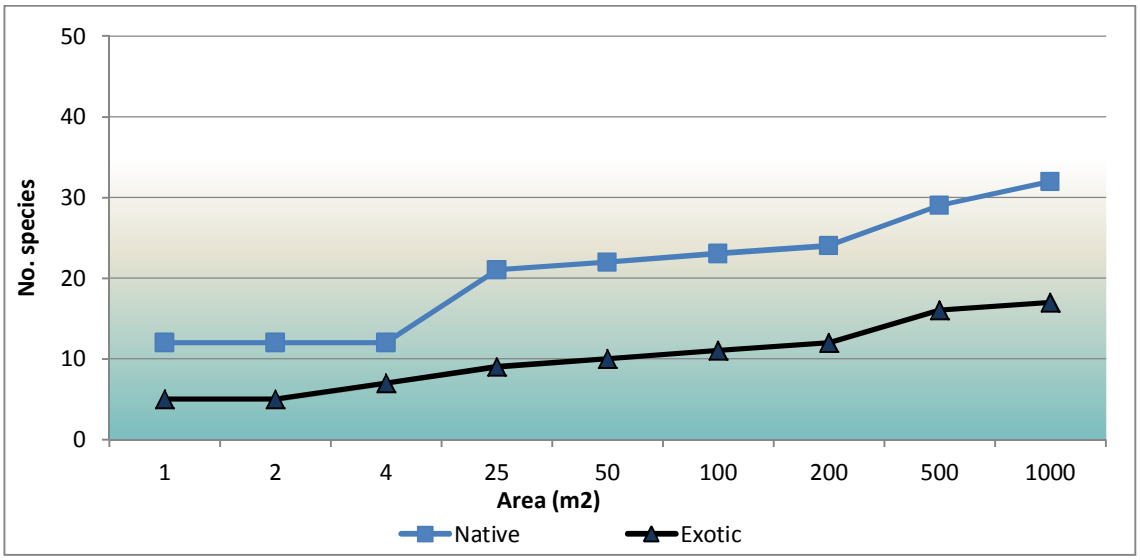


Figure 10-17. Cumulative species in the 50m x 20m (1000m²) monitoring quadrat.

Table 10-26. Cumulative species diversity.

Area (m2)	1	2	4	25	50	100	200	500	1000
Native	12	12	12	21	22	23	24	29	32
Exotic	5	5	7	9	10	11	12	16	17

10.3.9 Growth forms

Figure 10-18 is a summary of species in each growth form that were recorded in EOA-03. Herbs continued to be the most dominant growth with 35 species including 15 exotic species. There were 12 grass species and only two of these were exotic. This year there was one tree species which was recorded for the first time and one native reed species. There continued to be no shrub or sub-shrub species and the fern species recorded last year was not present this year. Compared to the composition of the reference sites this site lacked two tree species.

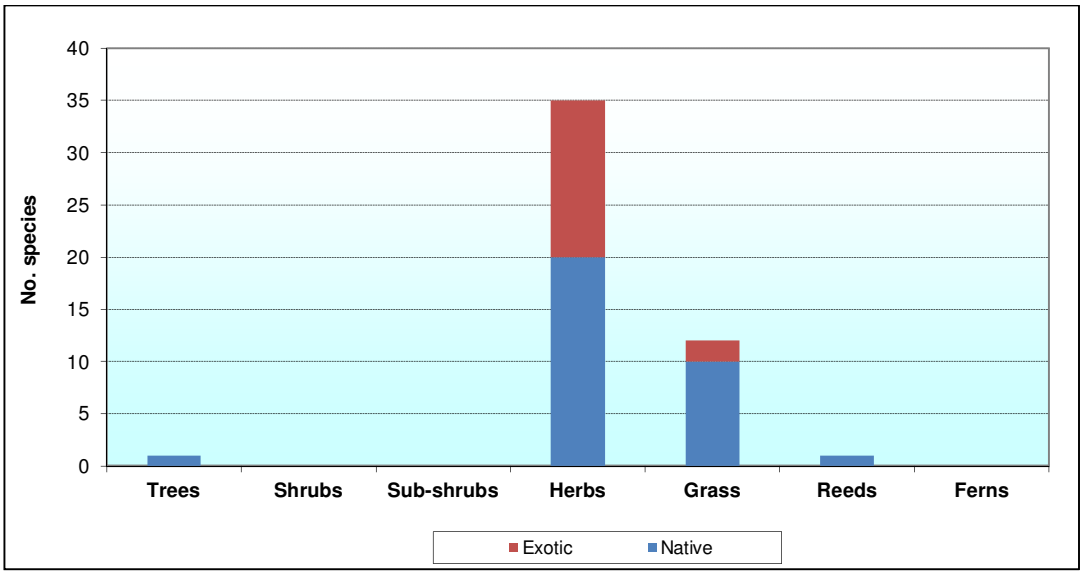


Figure 10-18. Graph illustrating the growth forms of species recorded in the 50m x 20m monitoring quadrat.

10.3.10 Comparison of rehabilitation data with key performance indicators

Table 10-27 indicates the performance of the monitoring site against the Completion and Desirable Performance Indicators developed for woodland sites during the 2012 monitoring period. The selection of criteria have been presented in order of ecosystem successional processes, beginning with landform establishment (orange) for example and ending with indicators of ecological stability (blue). The range values will be amended annually.

Rehabilitation sites meeting or exceeding the range values of their representative community type have identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 10-27. Comparison of key performance Indicators recorded site EOA-03 compared to lower and upper limits recorded in the woodland reference sites.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
Performance indicators are quantified by the range of values obtained from replicated reference sites							Lower	Upper	2010	2011	2012
Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope		Landform is generally compatible within the context of the local topography.	< Degrees (18°)	0	5	0	0	0
	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation		%	63.5	71.0	77.5	77.5	73.0
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation		%	44.4	52.8	45.4	51.7	52.0
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation		%	40.9	51.6	43.7	48.8	49.6
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation		%	100	100	100	100	100
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising		No.	0	0	0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0
Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	6.5	6.9	5.68	6.22	6.40
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.055	0.077	0.176	0.075	0.070
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	4.3	6.3	6.6	6.3	5.2
			Phosphorous		Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (50)	14.5	23.6	23.0	16.4	15.4
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (>12.5)	2.7	7.3	42.1	2.2	3.8
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	14.08	19.06	10.74	11.90	11.14
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	0.16	1.74	0.92	0.32	0.38
Ecosystem establishment	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	1	6	0	0	1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	na	NA	100
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	44	60	61	50	49
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	39	44	43	33	32
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<No./area	3	18	18	17	17

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	**30**	**134**	0	0	**7**
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**2**	**4**	0	0	**1**
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**0**	**3**	0	0	**0**
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**1**	**7**	0	0	**0**
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**19**	**41**	48	35	**35**
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**10**	**18**	12	14	**12**
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	0	0	**1**
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**0**	0	0	**0**
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	1	1	**0**
Ecosystem development and habitat complexity	**Protective ground cover**	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	**62**	**77**	6.5	43.0	**54.5**
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	**0**	**1**	30	7.0	**2.0**
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	**0**	**8**	2.5	0.0	**0**
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	**0**	**0**	0	0.0	**0**
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	**0**	**2**	0.0	0.0	**0**
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	**2**	**14**	2	0.0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	9	36	59	50.0	43.5
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	87	99	98	100	100
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m^2	4	6	12.8	10.2	8.6
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	0	1	3.4	2.2	3.0
		Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	88	96	81.1	85.6	81.3
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	5	48	0.0	0	7
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	17	0.0	0	0
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	20	0.0	0	0
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	19	0.0	0	0
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	51	0.0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
Ecological stability	**Ecosystem structure**	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**0**	**8**	0	1	**0**
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**0**	**7**	0	0	**0**
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**3**	**15**	0	0	**0**
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**15**	**44**	0	0	**0**
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	**3**	**3**	0	0	**0**
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	**100**	**100**	0	0	**0**
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density		The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation	No./area	**6**	**19**	0	0	**0**
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	**18**	**54**	0	0	**0**
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	**83**	**100**	0	0	**0**
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	**0**	**42**	0	0	**0**
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	**50**	**80**	0	0	**0**
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	**0**	**22**	0	0	**0**
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	**0**	**17**	0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-03		
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	**0**	**0**	0	0	**0**
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	**47**	**89**	0	0	**0**

10.4 EOA-04 site description

Estcourt Offset Area 04 (EOA-04) is situated on the edge of a woodland stand which contains a moderate canopy of *Callitris glaucophylla* trees of varying health, including numerous dead stags. The transect extended into an area of open grassland, which contained a higher diversity of native ground cover species than beneath the tree canopies. There was no *C. glaucophylla* recruitment but numerous trees were flowering or contained fruit. The site contained numerous fallen logs and branches. The understorey was relatively weedy with *Lolium sp* and *Trifolium* species being very common, but it retained high native species diversity and native perennial grasses were particularly dominant. There were no shrubs and no tree hollows were observed. The site had very high species diversity. In 2011, later monitoring and drier seasonal conditions has resulted in a reduction in floristic diversity. In 2012, there were 7 *Dodonaea* and two *Callitris* seedlings.

10.4.1 Landscape Function Analysis

10.4.1.1 Landscape organisation

EOA-04 continued to be characterised as a woodland patch with no interpatch areas leaking resources from the site which subsequently resulted in a Landscape Organisation Index of 1.0 or was 100% woodland patch (Figure 10-19, Table 10-28). The high abundance of native perennial species, leaf litter and fallen branches provided high levels of soil surface cover resulting a highly stable and functional community.

Since 2010 this site has demonstrated improved ecological function largely due to significant increase in depth of litter cover and higher states of decomposition. This year however there was a marginal decline in stability largely due to the decline in active perennial grass growth and no cryptogams were observed. Increased states of litter decomposition have however resulted in slight increase in infiltration and nutrient recycling capacity. The resultant LFA indices for stability, infiltration and nutrient recycling were 73.5, 52.7 and 48.3 respectively. Compared to the minimum range provide by the woodland reference sites, LFA indices were 10.0, 8.3 and 7.4 units higher.

Figure 10-19. Permanent photo point taken from the top of the LFA transect in 2011 (left) and 2012 (right).

Table 10-28. Summary of landscape organisation and LFA indices in 2010, 2011 and 2012.

EOA-04		24/9/2010		20/10/2011		18/10/2012	
Number of Patches/10m		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		NA		NA	
Range Interpatch length (m)		NA		NA		NA	
Patch or Interpatch Type		**Woodland Patch**		**Woodland Patch**		**Woodland Patch**	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment							
Within Individual Zones	**Stability**	70.0		76.0		73.5	
	Infiltration	43.7		49.9		52.7	
	Nutrients	37.6		46.0		48.3	
			Total		**Total**		**Total**
Individual zones contribution to the whole of Landscape	**Stability**	70.0	**70.0**	76.0	**76.0**	73.5	**73.5**
	Infiltration	43.7	**43.7**	49.9	**49.9**	52.7	**52.7**
	Nutrients	37.6	**37.6**	46.0	**46.0**	48.3	**48.3**

10.4.1.2 Soil Surface Assessment

The cover provided by perennial ground covers was not much different than recorded last year and these made only minor differences in the level of protection against rain splash and basal cover with the mature Callitris trees also providing high canopy cover. Dead grasses, annual plants and fallen twigs and leaves also provided a thick layer of litter cover which have accumulated some depth and this year slight to moderate levels decomposition were recorded across the site, even within the more open grassland area. The soils remained crusted but no cryptogams were observed this year probably due to the high levels of ground cover. The grass tussocks typically provided moderate soil surface relief and there was little to no evidence of erosion and deposition within the site despite high rainfall activity occurring earlier in the year. The loam soils remained moderately hard and very stable, due to the high levels of organic matter and humus.

Table 10-29 . Results of the Soils Surface Assessment for the Woodland patch.

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Soil Cover	5	3	3	5	3	3
Per. basal / canopy cover	4	3	4	4	4	4
Litter cover, orig & incorp.	10	6ls	6lm	6ls	6lm	6ls
Cryptogam cover	4	1	1	1	1	1
Crust broken-ness	4	4	4	4	4	4
Erosion type & severity	4	4	4	4	4	4
Deposited materials	4	4	4	4	4	4
Soil surface roughness	5	3	2	3	3	3
Surface resist. to disturb.	5	3	3	3	3	3
Slake test	4	4	4	4	4	4
Texture	4	3	3	3	3	3

10.4.2 Soil analyses

There has been little to no changes in the soil characteristics since 2010 and in all cases any change has been relatively insignificant. The soils remained slightly acidic and while they were slightly lower than the reference sites they continued to fall within the desirable levels prescribed by the agricultural industry (Table 10-30). The Electrical Conductivity Organic Matter content Phosphorous Nitrate and CEC levels continued to fall within local levels. There was little change in the Exchangeable Sodium Percentage (ESP) which remained within local levels and well below the desirable level of 5% indicating that the soils are non sodic.

Table 10-30. Results of the soil analysis for EOA-04 compared to the upper and lower values for the woodland reference sites and desirable levels in 2010, 2011 and 2012.

Nutrient	Units	EOA-04			Lower KPI	Upper KPI	*Desirable Level*
		2010	**2011**	**2012**			
pH (1:5 water)	units	6.07	6.07	6.16	6.48	6.87	*5.6 – 7.3*
Conductivity (1:5 water)	dS/m	0.063	0.079	0.078	0.05	0.08	*0.150*
Organic Matter	%	9.1	7.5	7.8	4.31	6.34	*>4.5*
Phosphorus (Colwell)	mg/kg	33	18	16	14.46	23.62	*50*
Nitrate	mg/kg	3.2	4.8	5.6	2.68	7.32	*13.0*
Cation Exchange Capacity	$cmol^+/Kg$	16.82	14.87	16.61	14.08	19.06	*14.00*
Exchangeable Sodium Percentage	%	0.18	0.22	0.20	0.16	1.74	<5

10.4.3 Rill assessment

No rills were observed within the monitoring quadrat in any monitoring year

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10.4.4 Tree density and health condition

There has been little change within this mature *Callitris glaucophylla* woodland patch which consists of 14 *Callitris glaucophylla* trees and seven dead stags over the past couple of years. They had an average dbh of 28cm but they ranged from 12 – 43cm in diameter. The majority of the live trees were remained in medium health, but two were healthy and two were considered to be in a state of advanced dieback, possibly due to the prolonged drought conditions increasing competition levels between the trees. Eleven individuals were in flower or were bearing cones. No mistletoe or tree hollows were observed.

Table 10-31. Summary of tree health and density.

Dominant species	*Callitris glaucophylla (14),* Stag (7)
Average dbh (Cm)	28
Max dbh (cm)	43
Min dbh (cm)	12
Total trees	21
No. with multiple limbs	2
No. Live trees	14
No. Healthy	2
No. Medium Health	10
No. Advanced Dieback	2
No. Dead	7
Mistletoe	0
Flowers / fruit	11

10.4.5 Shrubs and regeneration

In 2012 there has been further regeneration within this site with an additional four *Dodonaea viscosa subsp. cuneata* seedlings and two *Callitris glaucophylla* recorded resulting in a shrub and juvenile tree population of 10 individuals. Most of the individual were less than 0.5m in height but two *Dodonaea viscosa subsp. cuneata* were up to 1m in height.

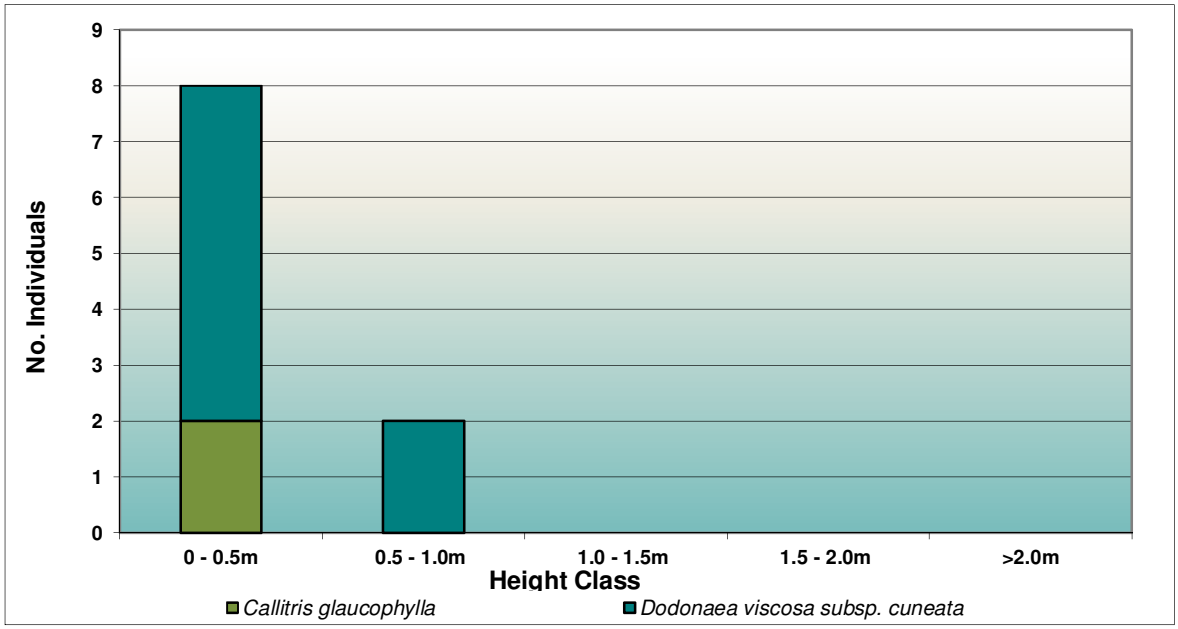


Figure 10-20. Shrubs and young trees occurring within the monitoring site.

Table 10-32. Shrubs and young trees occurring within the monitoring site.

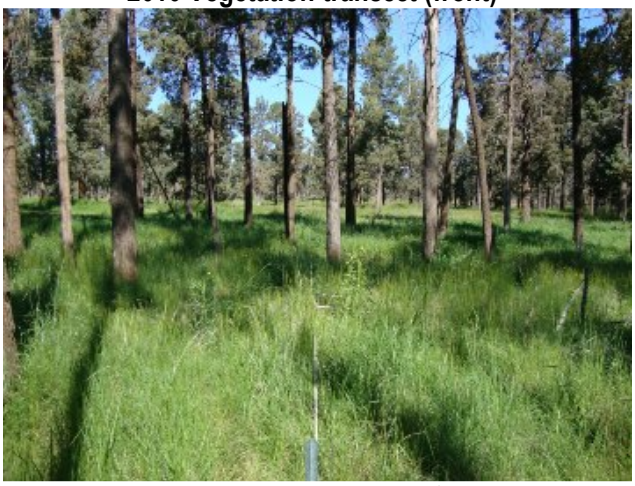
Species	0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	>2.0m	Total	endemic	not endemic
Callitris glaucophylla	2					**2**	2	
Dodonaea viscosa subsp. cuneata	6	2				**8**	8	
Total	**8**	**2**	**0**	**0**	**0**	**10**	**10**	**0**
% endemic species							**100**	**0**

10.4.6 Structural diversity and habitat complexity

The floristic composition of site EOA-04 has changed very little over the past 12 months and remains relatively simple with average total ground cover decreasing slightly to 99.5% (Figure 10-21, Figure 10-22). There were still no live annual plants or cryptogams and perennial vegetation cover has further declined marginally from 42.5 - 37.5% this year due to the drier conditions. Conversely there has been a similar increase in dead litter cover which has increased from 57.5 to 62% on average. No logs and fallen branches were recorded along the vegetation transect but they were scattered across the larger remnant.

The canopy cover <6.0m remained variable and was present in the first half of the transect, with one tree providing some cover in the 2.0 - 4.0 and 4.0 - 6.0m height categories. There continued to be lack of projected foliage cover within the 0.5 – 2.0m height category. Average and minimum and maximum values of the structural diversity are recorded in Table 10-33.

2010 Vegetation transect (front)



2010 Vegetation transect (rear)

2011 Vegetation transect (front)

2011 Vegetation transect (rear)

2012 Vegetation transect (front)

2012 Vegetation transect (rear)

Figure 10-21. Permanent photo points taken from the front (left) and rear (right) of the vegetation transect.

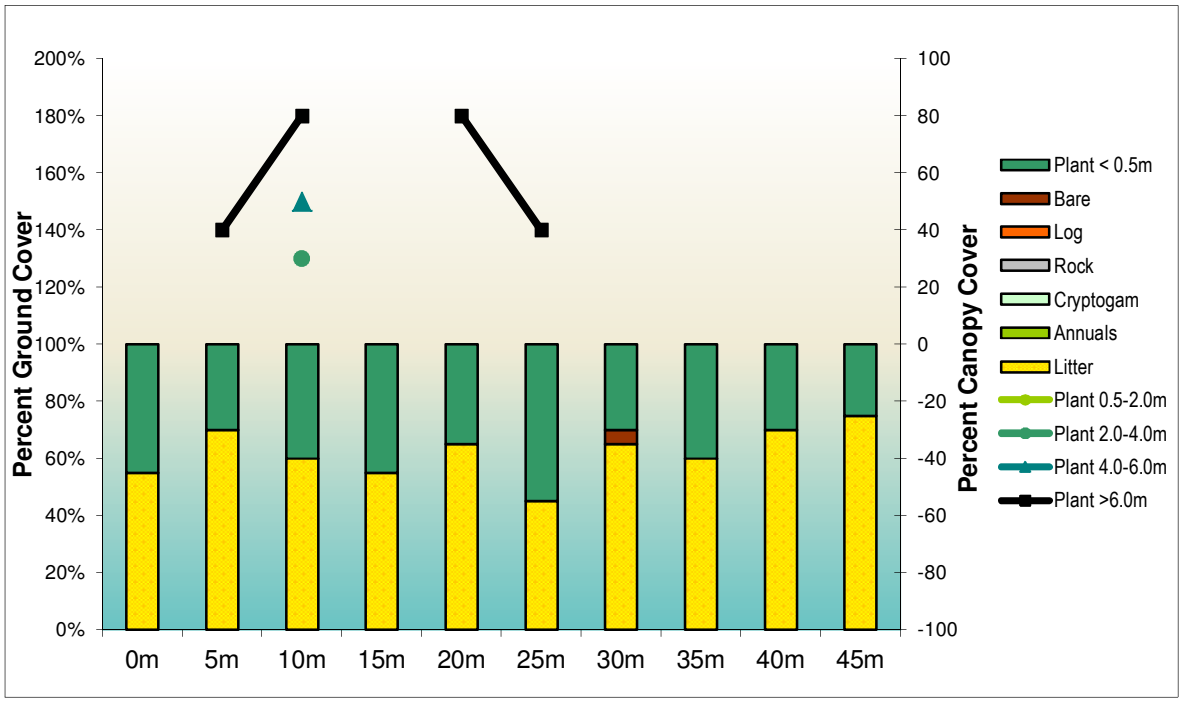


Figure 10-22. Graph illustrating the structural diversity and habitat complexity of the monitoring site.

Table 10-33. Average and minimum and maximum values of the structural diversity of the monitoring site.

Vegetation structure	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m	Average	Min	Max
Litter	55	70	60	55	65	45	65	60	70	75	**62**	**45**	**75**
Annuals	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Cryptogam	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Rock	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Log	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Bare	0	0	0	0	0	0	5	0	0	0	**0.5**	**0**	**5**
Perennial <0.5m	45	30	40	45	35	55	30	40	30	25	**37.5**	**25**	**55**
Total Ground Cover	100	100	100	100	100	100	95	100	100	100	**99.5**	**95**	**100**
0.5-2.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
2.0-4.0m	0	0	30	0	0	0	0	0	0	0	**3**	**0**	**30**
4.0-6.0m	0	0	50	0	0	0	0	0	0	0	**5**	**0**	**50**
>6.0m	0	40	80	0	80	40	0	0	0	0	**24**	**0**	**80**

10.4.7 Species cover abundance

This year there has been a significant further reduction in species recorded in the five 1m^2 quadrats on the permanent vegetation transect line, with a total of 18 species compared to 37 in 2010 and 25 in 2011. Only two of the species recorded in 2012 were exotic species. Using the Braun-blanquet scale, the highest possible cover score that can be obtained is 30. Cover abundance is illustrated as a sum of scores (class values) obtained along the five 1m^2 quadrats. Figure 10-23 and Table 10-34 illustrate that the native perennial grass *Austrostipa scabra* subsp. *scabra* has become the most dominant species and was recorded in four of the five quadrats. The cover abundance of *Austrodanthonia eriantha,* which was the most dominant species last year, has decreased substantially though it remains among the most abundant species along with *Sida corrugata, Austrodanthonia racemosa* and *Dichondra repens*. The remaining species were recorded on less than two occasions or provided low cover values. *Lolium rigidum* and *Echium plantagineum* were the only exotic species recorded. Of the live plant cover scores recorded 96.4% was provided by native species.

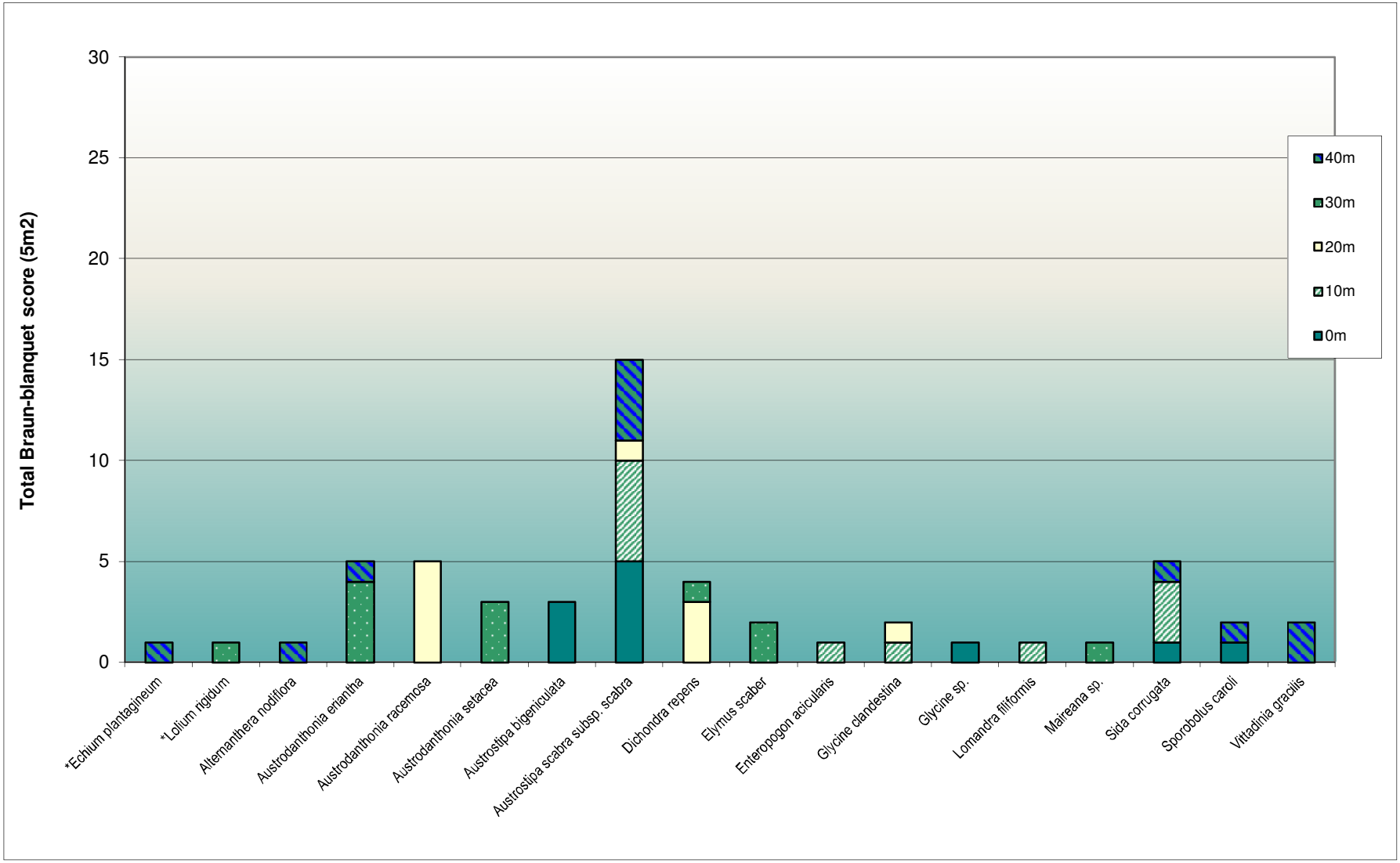


Figure 10-23. Total species recorded across the five, 1m² quadrats using the Braun-blanquet scale (max possible score is 30) as a measure of cover abundance.

Table 10-34. List of species and their average cover abundance score across the five, 1m² monitoring quadrats.

Species	0m	10m	20m	30m	40m	Total
**Echium plantagineum*					1	1
**Lolium rigidum*				1		1
Alternanthera nodiflora					1	1
Austrodanthonia eriantha				4	1	5
Austrodanthonia racemosa			5			5
Austrodanthonia setacea				3		3
Austrostipa bigeniculata	3					3
Austrostipa scabra subsp. scabra	5	5	1		4	15
Dichondra repens			3	1		4
Elymus scaber				2		2
Enteropogon acicularis		1				1
Glycine clandestina		1	1			2
Glycine sp.	1					1
Lomandra filiformis		1				1
Maireana sp.				1		1
Sida corrugata	1	3			1	5
Sporobolus caroli	1				1	2
Vittadinia gracilis					2	2
Total cover						55
Sum of cover of native species						53
Percent endemic species cover						**96.4**

10.4.8 Floristic diversity

The floristic diversity of the sites was measured using two different methods. One provides an assessment of the average number of species within five, one square metre (m²) sub-quadrats along the vegetation transect, while the other provides the total number of species within the entire 50x20m monitoring plot.

10.4.8.1 Species diversity per m²

There has been a further decline in native species this year with the number of native species declining to five species per m² compared to 10.2 in 2010 and 7.6 in 2011. Exotic species have increased slightly this year to 0.4 species per m² (Table 10-35). The number of native species ranged between 4 – 6 species per m², while exotic species were recorded once in two of the replicates.

Table 10-35. Species diversity per 1m².

Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	5	5	4	5	6	**5**	0.7
Exotic	0	0	0	1	1	**0.4**	0.5
Total	**5**	**5**	**4**	**6**	**7**	**5.4**	1.1

10.4.8.2 Total species diversity

The overall floristic diversity has further declined with a total of 47 species recorded in 2012 compared to 54 in 2011 and 71 in 2010. This year 38 native (one less than 2011) and nine exotic species were

recorded in the 50 x 20m monitoring quadrat (Figure 10-24, Table 10-36). A full list of species recorded within the monitoring site is provided in Appendix 1.

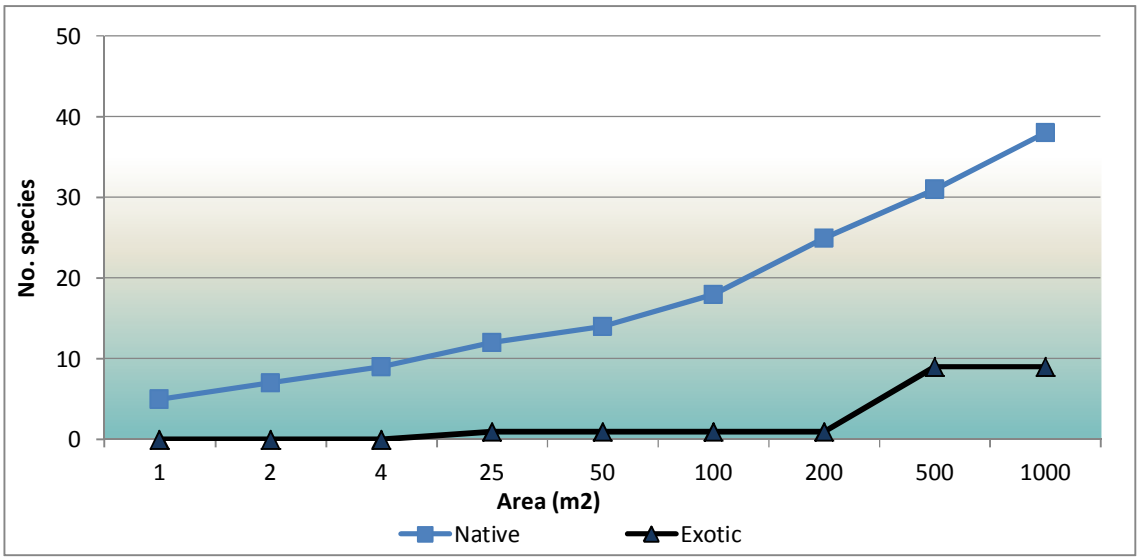


Figure 10-24. Cumulative species in the 50m x 20m (1000m²) monitoring quadrat.

Table 10-36. Cumulative species diversity.

Area (m2)	1	2	4	25	50	100	200	500	1000
Native	5	7	9	12	14	18	25	31	38
Exotic	0	0	0	1	1	1	1	9	9

10.4.9 Growth forms

Figure 10-25 is a summary of species in each growth form that were recorded in EOA-04. The site continued to be dominated by herbs, though the total has reduced to 26 different species, including 8 exotic species. There continued to be 14 different grass species and only one exotic species was observed within the monitoring plot compared to three last year. There was an additional sub-shrub with a total of three species and one species each of tree, shrub, reed and fern. Compared to the composition of the reference sites the site lacked the diversity of two tree species.

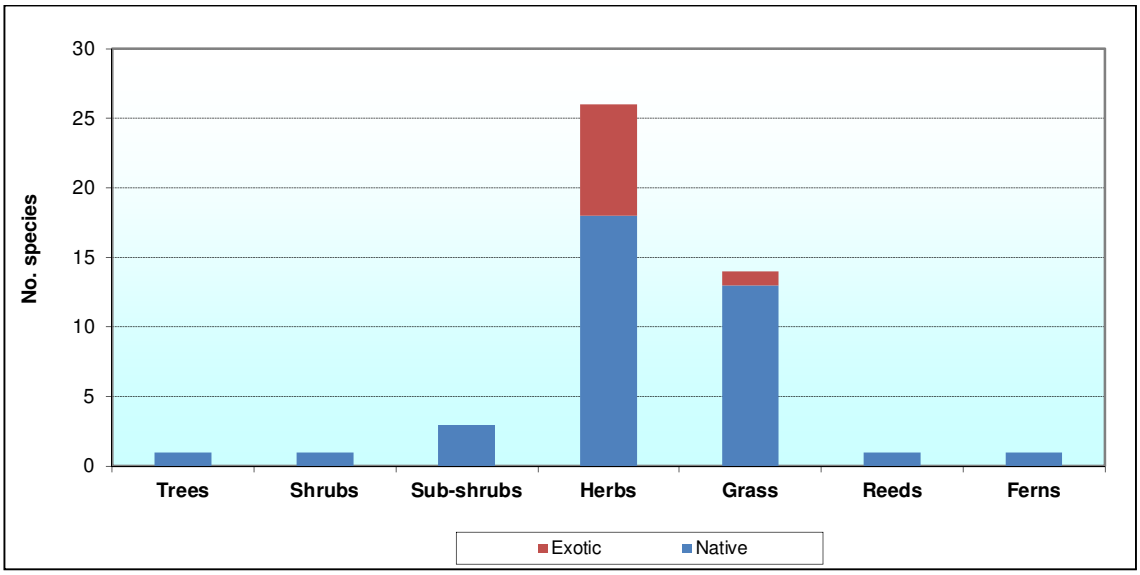


Figure 10-25. Graph illustrating the growth forms of species recorded in the 50m x 20m monitoring quadrat.

10.4.10 Comparison of rehabilitation data with key performance indicators

Table 10-37 indicates the performance of the monitoring site against the Completion and Desirable Performance Indicators developed for woodland sites during the 2012 monitoring period. The selection of criteria have been presented in order of ecosystem successional processes, beginning with landform establishment (orange) for example and ending with indicators of ecological stability (blue). The range values will be amended annually.

Rehabilitation sites meeting or exceeding the range values of their representative community type have identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 10-37. Comparison of key performance Indicators recorded at site EOA-04 compared to lower and upper limits recorded in the woodland reference sites.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
Performance indicators are quantified by the range of values obtained from replicated reference sites							Lower	Upper	2010	2011	2012
Landform establishment and stability	**Landform slope, gradient**	Landform suitable for final landuse and generally compatible with surrounding topography	Slope		Landform is generally compatible within the context of the local topography.	< Degrees (18°)	**0**	**5**	1	1	1
	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation		%	**63.5**	**71.0**	70.0	76.0	**73.5**
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation		%	**44.4**	**52.8**	43.7	49.9	**52.7**
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation		%	**40.9**	**51.6**	37.6	46.0	**48.3**
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation		%	**100**	**100**	100	100	**100**
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising		No.	**0**	**0**	0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0
Growth medium development	**Soil chemical, physical properties and amelioration**	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	**6.5**	**6.9**	6.07	6.07	6.16
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	**0.055**	**0.077**	0.063	0.079	0.078
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	**4.3**	**6.3**	9.1	7.5	**7.8**
			Phosphorous		Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (50)	**14.5**	**23.6**	32.8	17.8	**15.6**
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (>12.5)	**2.7**	**7.3**	3.2	4.8	**5.6**
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	**14.08**	**19.06**	16.8	14.87	**16.61**
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	**0.16**	**1.74**	0.18	0.22	**0.20**
Ecosystem establishment	**Vegetation diversity**	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	**1**	**6**	0	1	**2**
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	**100**	**100**	na	100	**100**
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	**44**	**60**	71	54	**47**
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	**39**	**44**	51	39	**38**
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<No./area	**3**	**18**	20	15	**9**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	**30**	**134**	0	4	**10**
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**2**	**4**	1	1	**1**
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**0**	**3**	0	1	**1**
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**1**	**7**	0	2	**3**
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**19**	**41**	53	35	**26**
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**10**	**18**	16	14	**14**
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	0	1	**1**
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**0**	0	0	**0**
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	**0**	**1**	1	0	**1**
Ecosystem development and habitat complexity	**Protective ground cover**	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	**62**	**77**	11	57.5	**62**
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	**0**	**1**	24.5	0.0	**0**
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	**0**	**8**	6	0.0	**0**
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	**0**	**0**	0	0.0	**0**
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	**0**	**2**	0.0	0.0	**0**
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	**2**	**14**	3	0.0	**0.5**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	9	36	55.5	42.5	37.5
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	87	99	97	100	99.5
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m^2	4	6	10.2	7.6	5
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	0	1	3.8	0.2	0.4
		Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	88	96	75.4	98.6	96.4
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	5	48	0.0	4	8
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	17	0.0	0	2
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	20	0.0	0	0
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	19	0.0	0	0
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	51	0.0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
Ecological stability	**Ecosystem structure**	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**0**	**8**	0	0	**0**
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**0**	**7**	0	3	**3**
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	**3**	**15**	4	7	**5**
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	**15**	**44**	22	18	**24**
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	**3**	**3**	1	1	**1**
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	**100**	**100**	100	100	**100**
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density		The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation	No./area	**6**	**19**	21	21	**21**
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	**18**	**54**	28	28	**28**
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	**83**	**100**	67	66.7	**66.7**
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	**0**	**42**	14.0	9.5	**9.5**
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	**50**	**80**	38	38.1	**47.6**
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	**0**	**22**	14.0	9.5	**9.5**
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	**0**	**17**	33	33.3	**33.3**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-04		
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	**0**	**0**	0.0	0	**0**
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	**47**	**89**	48.0	47.6	**52.4**

10.5 EOA-05 site description

Estcourt Offset Area 05 (EOA-05) was situated to the north east of the site within a sparse woodland stand of *Callitris glaucophylla* trees, including two dead stags. In 2010 there was no *C. glaucophylla* recruitment but the trees were flowering or contained fruit. The understorey was relatively weedy (23 exotic species) especially beneath the trees where there were remnant stockcamps, with *Lolium* and *Trifolium* species being very common, but it retained high native species diversity (49 species) and native perennial grasses were particularly dominant. There were no shrubs and one tree hollow was observed in one of the dead stags. The site had very high species diversity (72 species). In 2011, later monitoring and drier seasonal conditions has resulted in a reduction in floristic diversity. In 2012 11 *C. glaucophylla* seedlings were found.

10.5.1 Landscape Function Analysis

10.5.1.1 Landscape organisation

EOA-05 continued to be characterised as a woodland patch with no interpatch areas leaking resources from the within the site (Figure 10-26, Table 10-38), which subsequently resulted in a Landscape Organisation Index of 1.0 (100% woodland patch). Between 2010 and 2011 this site had had little change in stability but a marked improvement in infiltration and nutrient recycling has occurred largely due to increased extent and depth of litter cover, higher states of litter decomposition and reduced surface crusting and soil hardness. In 2012 however there was a marginal decline in stability and nutrient recycling and this was largely due a combination of reduced perennial plant and cryptogam covers. There was however a slight increase in infiltration.

The resultant LFA indices for stability, infiltration and nutrient recycling were 73.5, 48.9 and 46.0 respectively. Compared to the minimum KPI target provided by the woodland reference sites, this site had LFA indices which were 10.0, 4.5 and 5.1 units higher respectively.

Figure 10-26. Permanent photo point taken from the top of the LFA transect in 2011 (left) and 2012 (right).

Table 10-38. Summary of landscape organisation and LFA indices in 2010, 2011 and 2012.

EOA-05		24/9/2010		20/10/2011		18/10/2012	
Number of Patches/10m		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		NA		NA	
Range Interpatch length (m)		NA		NA		NA	
Patch or Interpatch Type		**Grassy Woodland Patch**		**Grassy Woodland Patch**		**Grassy Woodland Patch**	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment							
Within Individual Zones	**Stability**	78.0		78.5		73.5	
	Infiltration	38.4		48.5		48.9	
	Nutrients	40.0		48.8		46.0	
			Total		**Total**		**Total**
Individual zones contribution to the whole of Landscape	**Stability**	78.0	**78.0**	78.5	**78.5**	73.5	**73.5**
	Infiltration	38.4	**38.4**	48.5	**48.5**	48.9	**48.9**
	Nutrients	40.0	**40.0**	48.8	**48.8**	46.0	**46.0**

10.5.1.2 Soil Surface Assessment

There was a slightly lower levels of perennial plant cover this year which continued to provide variable levels of protective ground cover and was largely provided by the native perennial grasses as the tree canopies were too sparse to provide significant canopy cover (Table 10-39). There continued to be high cover of dead leaf litter which had accumulated to some depth across the site and while in most of the site the litter was in slight states of decomposition, moderate decomposition was observed in one sample indicating improved levels of microbial and fungal activity.

The soils remained crusted but there was a significant loss of cryptogams probably due to the increasing levels of ground cover. The vegetation and heavy litter covers continued to provide moderate soil surface relief and there was little to no evidence of erosion or deposition despite the high rainfall activity over summer. The clay loam soils continued to be moderately hard across the site and due to the developing humus layer they remained very stable.

Table 10-39 . Results of the Soils Surface Assessment for the Grassy Woodland patch.

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Soil Cover	5	3	3	3	5	2
Per. basal / canopy cover	4	3	3	3	4	2
Litter cover, orig & incorp.	10	6lm	6ls	6ls	6ls	6ls
Cryptogam cover	4	1	1	2	1	1
Crust broken-ness	4	4	4	4	4	4
Erosion type & severity	4	4	4	4	4	4
Deposited materials	4	4	4	4	4	4
Soil surface roughness	5	3	3	3	3	3
Surface resist. to disturb.	5	3	3	3	3	3
Slake test	4	4	4	4	4	4
Texture	4	2	2	2	2	2

10.5.2 Soil analyses

There has been little to no changes in the soil characteristics since 2010 and in all cases any change has been relatively insignificant. The soils remained slightly acidic and while they were slightly lower than the reference sites they continued to fall within the desirable levels prescribed by the agricultural industry (Table 10-40). The Electrical Conductivity, Organic Matter, Phosphorous and Nitrate concentrations fell within local levels but CEC levels were low. There was a slight reduction in the Exchangeable Sodium Percentage (ESP) which fell within local ranges and well below the desirable level of 5% indicating that the soils are non sodic.

Table 10-40. Results of the soil analysis for EOA-05 compared to the upper and lower values for the woodland reference sites and desirable levels 2010 - 2012.

Nutrient	Units	EOA-05			Lower KPI	Upper KPI	*Desirable Level*
		2010	**2011**	**2012**			
pH (1:5 water)	units	5.87	6.24	6.14	6.48	6.87	*5.6 – 7.3*
Conductivity (1:5 water)	dS/m	0.093	0.091	0.057	0.05	0.08	*0.150*
Organic Matter	%	4.8	6.1	4.8	4.31	6.34	*>4.5*
Phosphorus (Colwell)	mg/kg	18	15	16	14.46	23.62	*50*
Nitrate	mg/kg	22.0	6.2	4.5	2.68	7.32	*13.0*
Cation Exchange Capacity	$cmol^+/Kg$	12.73	13.67	12.15	14.08	19.06	*14.00*
Exchangeable Sodium Percentage	%	0.79	0.86	0.62	0.16	1.74	<5

10.5.3 Rill assessment

No rills were observed within the monitoring quadrat in any monitoring year.

10.5.4 Tree density and health condition

There was little change observed among the mature trees (>5cm dbh) with three *Callitris glaucophylla* and two dead stag trees existing within the 50 x 20m monitoring plot , which equates to a tree density of 50 trees per hectare (Table 10-41). This year all three of the live trees were considered to be in a healthy condition and all live trees contained fruits and/or flowers. The average dbh was 46cm and ranged from 18 – 67 cm. One of the stags contained tree hollows.

Table 10-41. Summary of tree health and density.

Dominant species	*Callitris glaucophylla (3),* Stag (2)
Average dbh (Cm)	46
Max dbh (cm)	67
Min dbh (cm)	18
Total trees	5
No. with multiple limbs	0
No. Live trees	3
No. Healthy	3
No. Medium Health	0
No. Advanced Dieback	0
No. Dead	2
Mistletoe	0
Flowers / fruit	3

10.5.5 Shrubs and regeneration

This year 11 *Callitris glaucophylla* seedlings were counted within site EOA-05 as a result of a natural recruitment event. All individuals were less than 0.5m in height and at the time of monitoring were approximately 5-10cm tall. Many other juvenile *C. glaucophylla, E. microcarpa* and *E. populnea* were now visible within the larger paddock areas a result of natural recruitment stimulated by the good summer rainfall over the past two years.

Table 10-42. Shrubs and young trees occurring within the monitoring site.

Species	0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	>2.0m	Total	endemic	not endemic
Callitris glaucophylla	11					**11**	11	
Total	**11**	**0**	**0**	**0**	**0**	**11**	**11**	**0**
% endemic species							**100**	**0**

10.5.6 Structural diversity and habitat complexity

Site EOA-05 remains to be relatively simple in structure and continues to have 100% total ground cover (Figure 10-27, Figure 10-28). As with all of the other monitoring sites this year, there has been a reduction in perennial ground cover which had an average cover of 27% compared to 40.5% last year and 52% in 2010. This year no live annual vegetation was recorded and there was an increase in dead litter cover which provided 72% of the ground cover on average. With the high ground cover, there continued to be no cryptogams recorded along the transect this year. A small branch, which presumably fell from the tree above provided a small amount of cover at the 15m mark on the transect.

The Callitris trees were sparsely distributed in this area but one Callitris tree provided some canopy cover in the 4 - 6m and >6.0m vertical height categories at 15m along the transect. No other vertical foliage cover was recorded and the site lacked vertical complexity. Average and minimum and maximum values of the structural diversity are recorded in Table 10-43.

2010 Vegetation transect (front)

2010 Vegetation transect (rear)

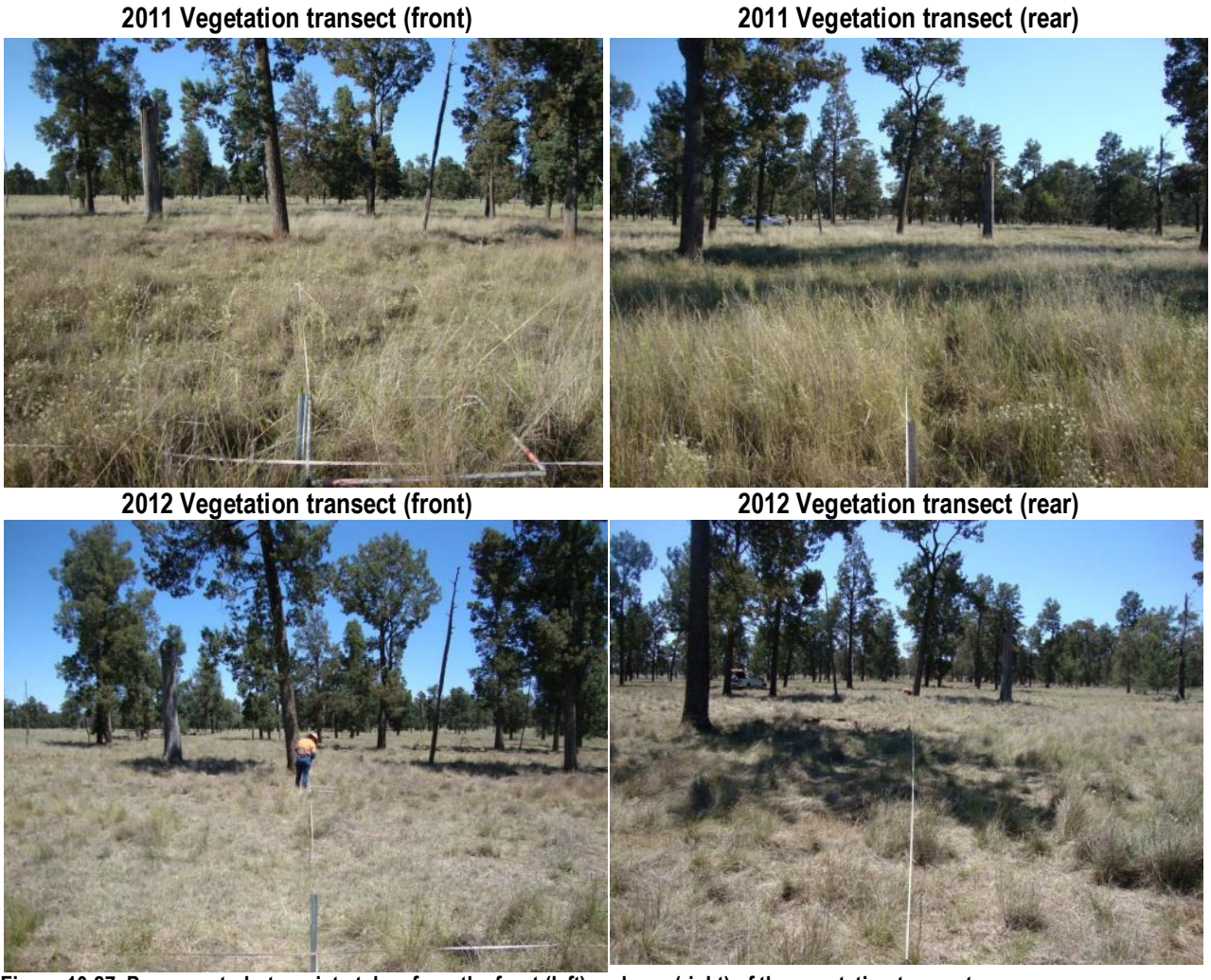


Figure 10-27. Permanent photo points taken from the front (left) and rear (right) of the vegetation transect.

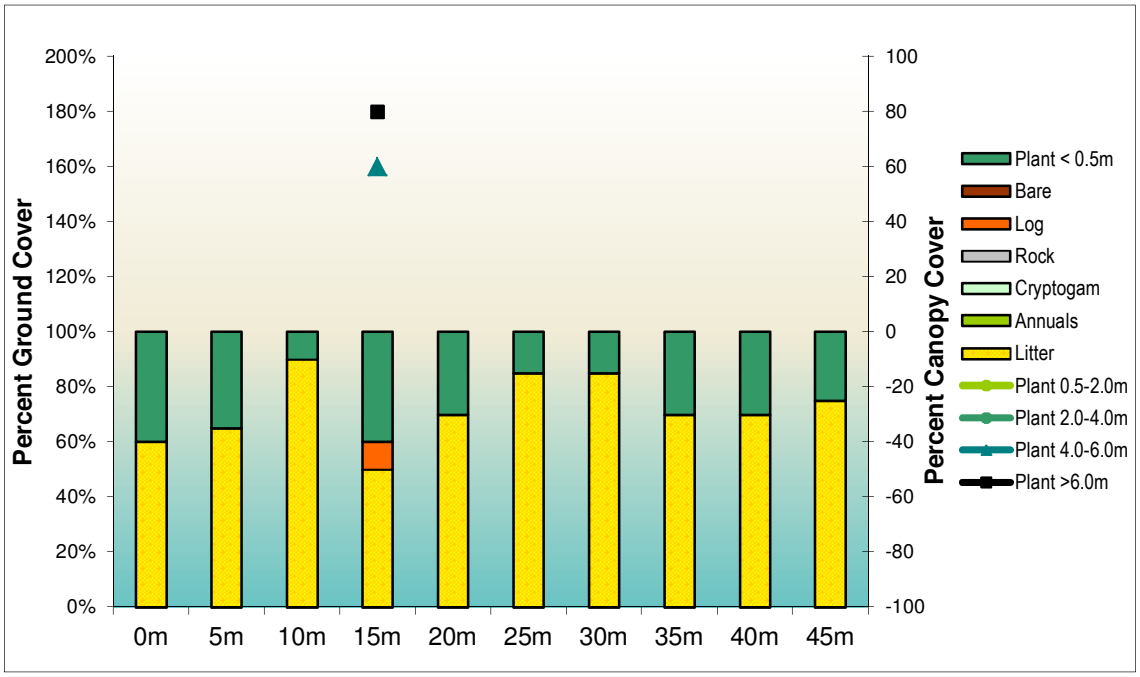


Figure 10-28. Graph illustrating the structural diversity and habitat complexity of the monitoring site.

Table 10-43. Average and minimum and maximum values of the structural diversity of the monitoring site.

Vegetation structure	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m	Average	Min	Max
Litter	60	65	90	50	70	85	85	70	70	75	**72**	**50**	**90**
Annuals	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Cryptogam	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Rock	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Log	0	0	0	10	0	0	0	0	0	0	**1**	**0**	**10**
Bare	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Perennial <0.5m	40	35	10	40	30	15	15	30	30	25	**27**	**10**	**40**
Total Ground Cover	100	100	100	100	100	100	100	100	100	100	**100**	**100**	**100**
0.5-2.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
2.0-4.0m	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
4.0-6.0m	0	0	0	60	0	0	0	0	0	0	**6**	**0**	**60**
>6.0m	0	0	0	80	0	0	0	0	0	0	**8**	**0**	**80**

10.5.7 Species cover abundance

Total species diversity in 2012 has remained unchanged compared to 2011 with 22 species recorded in the five 1m^2 quadrats on the permanent vegetation transect line, though this year there was only one exotic species compared to three last year. Using the Braun-blanquet scale, the highest possible cover score that can be obtained is 30. Cover abundance is illustrated as a sum of scores (class values) obtained along the five 1m^2 quadrats. Figure 10-29 and Table 10-44 illustrate that *Austrostipa bigeniculata* and *Austrostipa scabra subsp. falcata* continued to be among the most common and abundant with other common species including *Austrodanthonia eriantha, Dichondra repens, Chloris truncata, Sporobolus caroli* and *Vittadinia pterochaeta*. *Lolium rigidum* was once quite a dominant, but due to the drier conditions it was only found in low abundance in three of the replicates. The remaining species were recorded less frequently and/or provided low cover values. Of the live plant cover scores recorded, 96.3% was provided by native species.

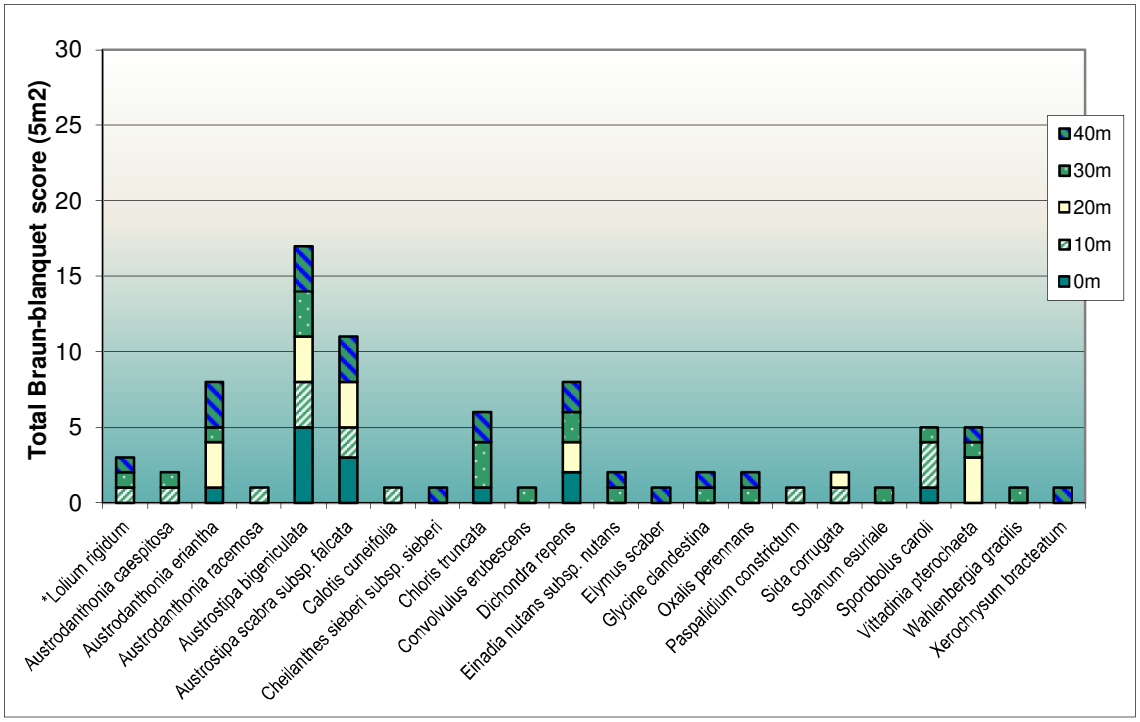


Figure 10-29. Total species recorded across the five, 1m² quadrats using the Braun-blanquet scale (max possible score is 30) as a measure of cover abundance.

Table 10-44. List of species and their average cover abundance score across the five, 1m² monitoring quadrats.

Species	0m	10m	20m	30m	40m	Total
**Lolium rigidum*		1		1	1	3
Austrodanthonia caespitosa		1		1		2
Austrodanthonia eriantha	1		3	1	3	8
Austrodanthonia racemosa		1				1
Austrostipa bigeniculata	5	3	3	3	3	17
Austrostipa scabra subsp. falcata	3	2	3		3	11
Calotis cuneifolia		1				1
Cheilanthes sieberi subsp. sieberi					1	1
Chloris truncata	1			3	2	6
Convolvulus erubescens				1		1
Dichondra repens	2		2	2	2	8
Einadia nutans subsp. nutans				1	1	2
Elymus scaber					1	1
Glycine clandestina				1	1	2
Oxalis perennans				1	1	2
Paspalidium constrictum		1				1
Sida corrugata		1	1			2
Solanum esuriale				1		1
Sporobolus caroli	1	3		1		5
Vittadinia pterochaeta			3	1	1	5
Wahlenbergia gracilis				1		1
Xerochrysum bracteatum					1	1
Total cover						82
Sum of cover of native species						79
Percent endemic species cover						**96.3**

10.5.8 Floristic diversity

The floristic diversity of the sites was measured using two different methods. One provides an assessment of the average number of species within five, one square metre (m²) sub-quadrats along the vegetation transect, while the other provides the total number of species within the entire 50x20m monitoring plot.

10.5.8.1 Species diversity per m²

There has been a slight reduction in native and exotic species diversity with 9 native and 0.6 exotic species per m² recorded in 2012 compared to 9.2 natives and 1.2 exotics in 2011 (Table 10-45). The number of native species ranged between 6 – 13 species per m², while the number of exotic species ranged between 0 – 1 species per m².

Table 10-45. Species diversity per 1m².

Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	6	8	6	13	12	**9**	3.3
Exotic	0	1	0	1	1	**0.6**	0.5
Total	**6**	**9**	**6**	**14**	**13**	**9.6**	3.8

10.5.8.2 Total species diversity

2012 has seen an increase in the overall floristic diversity in the 50 x 20m monitoring quadrat with a total of 51 species recorded compared to 48 species last year, although this was still significantly lower than the 72 species recorded in 2010. In 2012, 39 species were native which is an increase of four compared to 2011 (Figure 10-30, Table 10-46). A list of species recorded within the monitoring site is provided in Appendix 1.

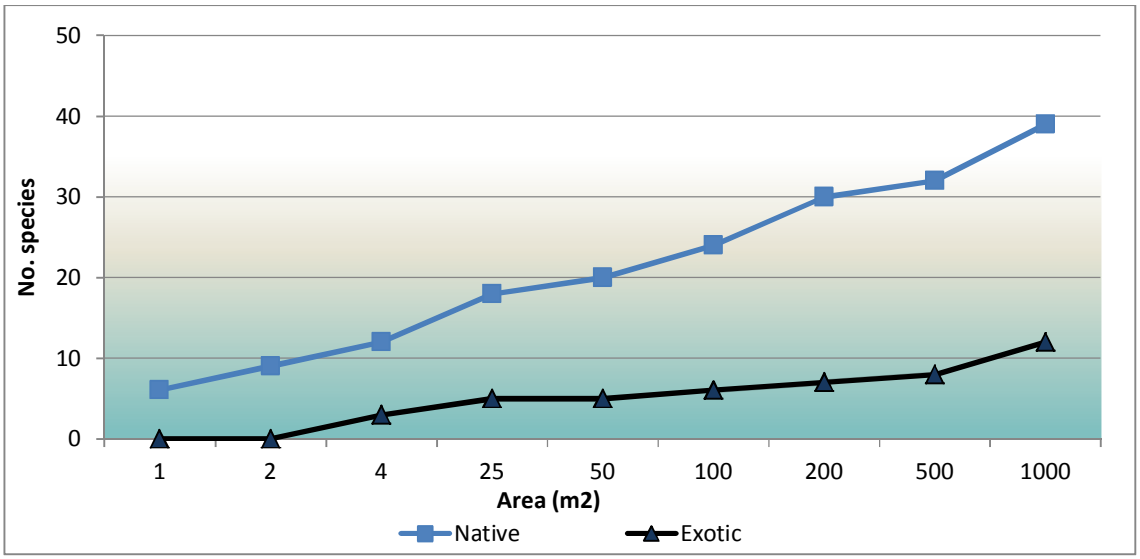


Figure 10-30. Cumulative species in the 50m x 20m (1000m²) monitoring quadrat.

Table 10-46. Cumulative species diversity.

Area (m2)	1	2	4	25	50	100	200	500	1000
Native	6	9	12	18	20	24	30	32	39
Exotic	0	0	3	5	5	6	7	8	12

10.5.9 Growth forms

Figure 10-31 is a summary of species in each growth form that were recorded in EOA-05. The site continued to be dominated by herbs with 22 native and 9 exotic species with a total of three more than in 2011. There were 16 different grass species and of these three were exotic species. There was one species each of tree, sub-shrub, reed and fern and all of these were native species. There continued to be a lack of shrub species. Compared to the composition of the reference sites the site lacked two tree species.

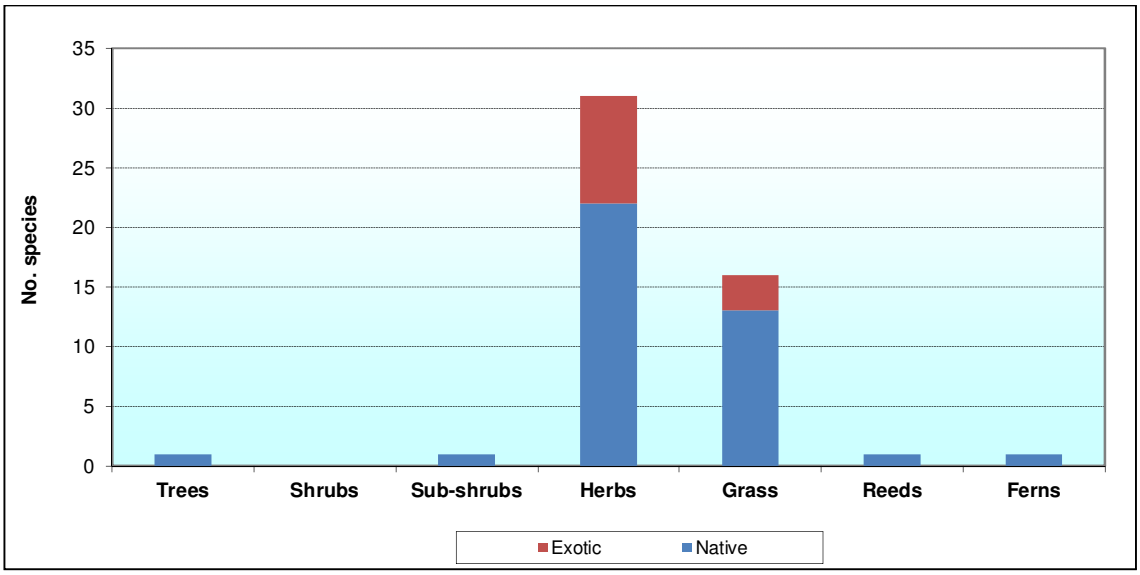


Figure 10-31. Graph illustrating the growth forms of species recorded in the 50m x 20m monitoring quadrat.

10.5.10 Comparison of rehabilitation data with key performance indicators

Table 10-47 indicates the performance of the monitoring site against the Completion and Desirable Performance Indicators developed for woodland sites during the 2012 monitoring period. The selection of criteria have been presented in order of ecosystem successional processes, beginning with landform establishment (orange) for example and ending with indicators of ecological stability (blue). The range values will be amended annually.

Rehabilitation sites meeting or exceeding the range values of their representative community type have identified with a shaded colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2012. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 10-47. Comparison of key performance Indicators recorded at siteEOA-05 compared to lower and upper limits recorded in the woodland reference sites.

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
Performance indicators are quantified by the range of values obtained from replicated reference sites							Lower	Upper	2010	2011	2012
Landform establishment and stability	**Landform slope, gradient**	Landform suitable for final landuse and generally compatible with surrounding topography	Slope		Landform is generally compatible within the context of the local topography.	< Degrees (18°)	**0**	**5**	1	1	1
	Landform function	Landform is functional and performing as it was designed to do	LFA Stability	Based on key physical, biological and chemical characteristics the LFA stability index provides an indication of the sites stability and that it is comparable to or trending towards that of the local remnant vegetation		%	**63.5**	**71.0**	78.0	78.5	**73.5**
			LFA Infiltration	Based on key physical, biological and chemical characteristics the LFA infiltration index provides an indication of the sites infiltration capacity and that it is comparable to or trending towards that of the local remnant vegetation		%	**44.4**	**52.8**	38.4	48.5	**48.9**
			LFA Nutrient recycling	Based on key physical, biological and chemical characteristics the LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and that it is comparable to or trending towards that of the local remnant vegetation		%	**40.9**	**51.6**	40.0	48.8	**46.0**
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to that of the local remnant vegetation		%	**100**	**100**	100	100	**100**
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Provides an assessment of the number of gullies or rills occurring in a 50m transect and that these are limited and stabilising		No.	**0**	**0**	0	0	**0**

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0
Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	6.5	6.9	5.87	6.24	6.14
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.055	0.077	0.093	0.091	0.057
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	4.3	6.3	4.8	6.1	4.8
			Phosphorous		Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (50)	14.5	23.6	18.4	15.3	15.9
			Nitrate	Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (>12.5)	2.7	7.3	22.8	6.2	4.5
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	14.08	19.06	12.73	13.67	12.15
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	0.16	1.74	0.79	0.86	0.62
Ecosystem establishment	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	1	6	0	0	1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	na	NA	100
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	44	60	72	48	51
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	39	44	49	35	39
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<No./area	3	18	23	13	12

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	30	134	0	0	11
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	2	4	1	1	1
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	0	3	0	0	0
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	1	7	1	2	1
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	19	41	55	28	31
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	10	18	13	15	16
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	1	1	1	1
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	1	1	1	1
Ecosystem development and habitat complexity	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	62	77	10	58.5	72
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	0	1	27	1.0	0
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	0	8	7	0.0	0
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	0	0	0	0.0	0
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	0	2	0.5	0.0	1
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	2	14	3.5	0.0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	9	36	52	40.5	27
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	87	99	97	100	100
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m^2	4	6	13	9.2	9
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	0	1	4.0	1.2	0.6
		Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	88	96	78.7	91.8	96.3
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	5	48	0.0	0	11
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	17	0.0	0	0
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	20	0.0	0	0
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	19	0.0	0	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	51	0.0	0	0
Ecological stability	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	0	8	0	0	0
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	0	7	0	0	0
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	3	15	0	0	6
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	15	44	8	7	8
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	3	3	1	1	1
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	100	100	100	100	100
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density		The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation	No./area	6	19	5	5	5
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	18	54	46	46	46
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	83	100	60	60	60
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	0	42	60.0	40.0	60.0
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	50	80	0	20	0

Hierarchy of ecosystem succession	Aspect or ecosystem component	Completion criteria	Performance Indicators	Completion Performance Indicators Description	Desirable Performance Indicators Description	Unit of measurement	Woodland ecosystem range 2012		EOA-05		
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	**0**	**22**	0.0	0	**0**
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	**0**	**17**	40	40	**40**
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	**0**	**0**	0.0	0	**0**
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	**47**	**89**	60.0	60.0	**60**

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Appendix 1. List of flora species recorded in the EOA and the woodland reference sites in 2012

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Pteridophyta	Adiantaceae		*Cheilanthes sieberi subsp. sieberi*	Rock Fern	f				1	1		1		1
Monocotyledon	Anthericaceae		*Arthropodium milleflorum*	Vanilla-lily	h									
Monocotyledon	Anthericaceae		*Dichopogon sp.*	Chocolate Lily	h			1						1
Monocotyledon	Anthericaceae		*Tricoryne elatior*	Yellow Autumn-lily	h									1
Monocotyledon	Asphodelaceae	*	*Asphodelus fistulosus*	Onion Weed	h									
Monocotyledon	Asphodelaceae		*Bulbine bulbosa*	Bulbine Lily	h			1						
Monocotyledon	Colchicaceae		*Wurmbea dioica*	Early Nancy	h									
Monocotyledon	Cyperaceae		*Carex inversa*	Knob Sedge	r	1	1	1	1	1				1
Monocotyledon	Cyperaceae		*Fimbristylis dichotoma*	Common Fringe Rush	r									
Monocotyledon	Iridaceae	*	*Romulea rosea*	Onion Grass	h									
Monocotyledon	Juncaceae		*Juncus aridicola*	Tussock Rush	r									
Monocotyledon	Juncaceae		*Juncus sp.*	A Rush	r	1								
Monocotyledon	Juncaceae		*Juncus usitatus*		r	1	1							
Monocotyledon	Lomandraceae		*Lomandra filiformis*	Wattle Mat-rush	h				1		1			1
Monocotyledon	Lomandraceae		*Lomandra multiflora*	Many-flowered Mat-rush	h									1
Monocotyledon	Phormiaceae		*Dianella revoluta*	Native Flax Lily	h							1		
Monocotyledon	Poaceae		*Aristida behriana*	Bunch Wiregrass	g				1					
Monocotyledon	Poaceae		*Aristida jerichoensis var. jerichoensis*	Jericho Wiregrass	g							1		
Monocotyledon	Poaceae		*Austrodanthonia bipartita*	Wallaby Grass	g									
Monocotyledon	Poaceae		*Austrodanthonia caespitosa*	Wallaby Grass	g					1	1	1	1	
Monocotyledon	Poaceae		*Austrodanthonia eriantha*	Hill Wallaby Grass	g	1	1	1	1	1		1	1	
Monocotyledon	Poaceae		*Austrodanthonia racemosa*	Wallaby Grass	g				1	1				
Monocotyledon	Poaceae		*Austrodanthonia setacea*	Small-flowered Wallaby Grass	g	1			1		1	1	1	
Monocotyledon	Poaceae		*Austrodanthonia sp.*	Wallaby Grass	g		1							1
Monocotyledon	Poaceae		*Austrostipa bigeniculata*	Tall Speargrass	g	1		1	1	1		1	1	1
Monocotyledon	Poaceae		*Austrostipa nodosa*	A Speargrass	g						1			
Monocotyledon	Poaceae		*Austrostipa scabra subsp. falcata*	Speargrass	g			1		1		1	1	
Monocotyledon	Poaceae		*Austrostipa scabra subsp. scabra*	Rough Speargrass	g	1	1	1	1	1	1	1	1	1
Monocotyledon	Poaceae		*Austrostipa setacea*	Corkscrew Grass	g	1								
Monocotyledon	Poaceae		*Austrostipa sp.*		g									
Monocotyledon	Poaceae	*	*Avena fatua*	Wild Oats	g	1	1						1	

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Monocotyledon	Poaceae		*Bothriochloa macra*	Red-leg Grass	g				1			1		
Monocotyledon	Poaceae	*	*Bromus cartharticus*	Prairie Grass	g									
Monocotyledon	Poaceae	*	*Bromus diandrus*	Great Brome	g							1		
Monocotyledon	Poaceae	*	*Bromus molliformis*	Soft Brome	g	1	1			1				
Monocotyledon	Poaceae	*	*Cenchrus ciliaris*	Buffel Grass	g									
Monocotyledon	Poaceae	*	*Chloris gayana*	Rhodes Grass	g									
Monocotyledon	Poaceae		*Chloris truncata*	Windmill Grass	g	1	1	1	1	1	1		1	1
Monocotyledon	Poaceae		*Dichanthium sericeum*	Queensland Bluegrass	g	1	1					1		
Monocotyledon	Poaceae		*Digitaria divaricatissima*	Umbrella Grass	g									
Monocotyledon	Poaceae		*Digitaria sp.*		g			1		1				
Monocotyledon	Poaceae		*Elymus scaber*	Common Wheatgrass	g		1	1	1	1	1	1	1	1
Monocotyledon	Poaceae		*Enteropogon acicularis*	Curly Windmill Grass	g	1	1	1	1	1	1	1	1	1
Monocotyledon	Poaceae		*Eragrostis parviflora*	Weeping Lovegrass	g	1								
Monocotyledon	Poaceae		*Eriochloa crebra*	Cup Grass	g	1								
Monocotyledon	Poaceae	*	*Hordeum leporinum*	Barley Grass	g	1	1							1
Monocotyledon	Poaceae	*	*Lolium rigidum*	Wimmera Ryegrass	g	1	1	1	1	1	1	1	1	1
Monocotyledon	Poaceae	*	*Lolium sp.*	A Ryegrass	g									
Monocotyledon	Poaceae		*Panicum decompositum*	Native Millet	g				1					
Monocotyledon	Poaceae		*Panicum effusum*	Hairy Panic	g	1						1		1
Monocotyledon	Poaceae		*Panicum sp.*		g	1	1	1		1		1	1	
Monocotyledon	Poaceae		*Paspalidium constrictum*	Knottybutt Grass	g	1				1	1	1	1	
Monocotyledon	Poaceae	*	*Paspalum dilatatum*	Paspalum	g									
Monocotyledon	Poaceae	*	*Phalaris minor*	Lesser Canary Grass	g									
Monocotyledon	Poaceae		*Poa sieberiana*	Fine-leaf Tussock	g							1		
Monocotyledon	Poaceae	*	*Rostraria cristata*	Annual Cats Tail	g									1
Monocotyledon	Poaceae		*Sporobolus caroli*	Fairy Grass	g	1	1	1	1	1	1		1	
Monocotyledon	Poaceae		*Themeda triandra*	Kangaroo Grass	g									
Monocotyledon	Poaceae	*	*Vulpia sp.*		g	1	1	1		1				1
Monocotyledon	Poaceae		*Walwhalleya proluta*	Rigid Panic	g	1	1					1	1	1
Monocotyledon	Poaceae		*Walwhalleya subxerophilum*	Gilgai Grass, Cane Panic	g				1				1	1
Dicotyledon	Amaranthaceae		*Alternanthera nodiflora*	Common Joyweed	h				1					
Dicotyledon	Amaranthaceae		*Ptilotus exaltatus*	Lambs Tails	h						1		1	
Dicotyledon	Amaranthaceae		*Ptilotus spathulatus*	Pussy Tails	h									1
Dicotyledon	Apiaceae		*Daucus glochidiatus*	Australian Carrot	h			1		1				

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Dicotyledon	Asteraceae	*	*Arctotheca calendula*	Capeweed	h									
Dicotyledon	Asteraceae		*Brachyscome curvicarpa*	Curved-seed Daisy	h								1	
Dicotyledon	Asteraceae		*Brachyscome melanocarpa*		h									
Dicotyledon	Asteraceae		*Calocephalus sonderi*	Pale Beautyheads	h									1
Dicotyledon	Asteraceae		*Calotis anthemoides*	Cut-leaved Burr-daisy	h							1		
Dicotyledon	Asteraceae		*Calotis cuneifolia*	Purple Burr Daisy	h	1	1	1	1	1	1		1	
Dicotyledon	Asteraceae		*Calotis hispidula*	Bogan Flea	h									1
Dicotyledon	Asteraceae		*Calotis lappulacea*	Yellow Burr Daisy	h	1	1	1	1	1	1	1	1	
Dicotyledon	Asteraceae	*	*Carthamus lanatus*	Saffron Thistle	h	1	1	1	1					1
Dicotyledon	Asteraceae	*	*Centaurea melitensis*	Maltese Cockspur	h	1		1	1					1
Dicotyledon	Asteraceae	*	*Centaurea solstitialis*	St Barnaby's Thistle	h									
Dicotyledon	Asteraceae	*	*Chondrilla juncea*	Skeleton Weed	h			1						
Dicotyledon	Asteraceae		*Chrysocephalum apiculatum*	Common Everlasting	h							1		
Dicotyledon	Asteraceae	*	*Cichorium intybus*	Chicory	h	1	1							
Dicotyledon	Asteraceae	*	*Cirsium vulgare*	Spear Thistle	h	1						1	1	
Dicotyledon	Asteraceae	*	*Conyza bonariensis*	Fleabane	h	1			1	1				
Dicotyledon	Asteraceae	*	*Conyza sp.*	Fleabane	h									
Dicotyledon	Asteraceae		*Cymbonotus lawsonianus*	Bear's Ear	h	1						1		
Dicotyledon	Asteraceae		*Eclipta platyglossa*	Twin Heads	h									
Dicotyledon	Asteraceae		*Euchiton involucratus*	Star Cudweed	h									
Dicotyledon	Asteraceae		*Euchiton sphaericus*	Japanese Cudweed	h									
Dicotyledon	Asteraceae	*	*Gamochaeta spicata*	Spiked Cudweed	h									
Dicotyledon	Asteraceae		*Gnaphalium luteo-album*	Jersey Cudweed	h									1
Dicotyledon	Asteraceae	*	*Hedypnois cretica*	Cretan Weed	h			1						1
Dicotyledon	Asteraceae		*Hyalosperma semisterile*	Orange Sunray	h									
Dicotyledon	Asteraceae	*	*Hypochaeris glabra*	Smooth Catsear	h	1								
Dicotyledon	Asteraceae	*	*Hypochaeris radicata*	Flatweed	h	1		1						
Dicotyledon	Asteraceae	*	*Lactuca saligna*	Wild Lettuce	h	1	1							
Dicotyledon	Asteraceae	*	*Lactuca serriola*	Prickly Lettuce	h	1	1	1		1				1
Dicotyledon	Asteraceae		*Leiocarpa panaetioides*	Woolly Buttons	h								1	
Dicotyledon	Asteraceae		*Minuria leptophylla*	Minnie Daisy	h						1		1	
Dicotyledon	Asteraceae		*Pseudognaphalium luteoalbum*	Jersey Cudweed	h	1								
Dicotyledon	Asteraceae	*	*Scorzonera laciniata*		h									
Dicotyledon	Asteraceae		*Senecio quadridentatus*	Cotton Fireweed	h							1		

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Dicotyledon	Asteraceae	*	*Sonchus asper*	Prickly Sowthistle	h									
Dicotyledon	Asteraceae	*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1		1	1			1
Dicotyledon	Asteraceae	*	*Tragapogon porrifolius*	Salsify	h									
Dicotyledon	Asteraceae		*Triptilodiscus pygmaeus*	Austral Sunray	h			1	1					1
Dicotyledon	Asteraceae		*Vittadinia cuneata*	Fuzzweed	h						1			
Dicotyledon	Asteraceae		*Vittadinia cuneata var cuneata*	Fuzzweed	h	1	1	1	1	1				
Dicotyledon	Asteraceae		*Vittadinia cuneata var hirsuta*	Fuzzweed	h	1		1	1					1
Dicotyledon	Asteraceae		*Vittadinia gracilis*	A Fuzzweed	h			1	1	1				1
Dicotyledon	Asteraceae		*Vittadinia pterochaeta*	Rough Fuzzweed	h		1	1		1	1	1	1	1
Dicotyledon	Asteraceae		*Vittadinia sulcata*	A Fuzzweed	h					1	1			
Dicotyledon	Asteraceae		*Vittadinia tenuissima*	Western New Holland Daisy	h					1	1	1		
Dicotyledon	Asteraceae		*Xerochrysum bracteatum*	Golden Everlasting	h			1	1	1				1
Dicotyledon	Boraginaceae	*	*Buglossoides arvensis*	Corn Gromwell	h									1
Dicotyledon	Brassicaceae	*	*Brassica juncea*	Chinese Mustard	h									
Dicotyledon	Brassicaceae	*	*Capsella bursa-pastoris*	Shepherd's Purse	h									
Dicotyledon	Brassicaceae	*	*Lepidium africanum*	Peppercress	h	1		1	1	1				1
Dicotyledon	Brassicaceae	*	*Rapistrum rugosum*	Turnip Weed	h									
Dicotyledon	Brassicaceae	*	*Sisymbrium officinale*	Hedge Mustard	h									1
Dicotyledon	Campanulaceae		*Wahlenbergia aridicola*	A Bluebell	h									1
Dicotyledon	Campanulaceae		*Wahlenbergia gracilenta*	Australian Bluebell	h		1							1
Dicotyledon	Campanulaceae		*Wahlenbergia gracilis*	Sprawling Bluebell	h	1	1	1	1	1				
Dicotyledon	Campanulaceae		*Wahlenbergia luteola*	Australian Bluebell	h			1	1			1	1	1
Dicotyledon	Campanulaceae		*Wahlenbergia sp.*	Bluebell	h					1				
Dicotyledon	Campanulaceae		*Wahlenbergia stricta?*	Tall Bluebell	h						1			
Dicotyledon	Caryophyllaceae	*	*Cerastium glomeratum*	Mouse-ear Chickweed	h									
Dicotyledon	Caryophyllaceae	*	*Petrorhagia nanteuilii*	Proliferous Pink	h							1		1
Dicotyledon	Caryophyllaceae	*	*Polycarpon tetraphyllum*	Four-leaved Allseed	h									
Dicotyledon	Caryophyllaceae	*	*Spergularia rubra*	Sandspurry	h	1	1							
Dicotyledon	Casuarinaceae		*Allocasuarina luehmannii*	Bulloak	t						1		1	
Dicotyledon	Casuarinaceae		*Casuarina cristata*	Belah	t									
Dicotyledon	Casuarinaceae		*Casuarina cunninghamiana*	River Sheoak	t									
Dicotyledon	Chenopodiaceae		*Atriplex semibaccata*	Creeping Saltbush	ss	1	1						1	
Dicotyledon	Chenopodiaceae		*Atriplex spinibractea*	Spiny-fruit Saltbush	ss						1	1	1	
Dicotyledon	Chenopodiaceae		*Atriplex suberecta*	Sprawling saltbush	ss									

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Dicotyledon	Chenopodiaceae		*Chenopodium curvispicatum*	Cottony Saltbush	ss				1					
Dicotyledon	Chenopodiaceae		*Chenopodium desertorum subsp. anidiophyllum*	Mallee Goosefoot	ss							1	1	
Dicotyledon	Chenopodiaceae		*Einadia nutans subsp. linifolia*	Climbing Saltbush	h						1	1	1	
Dicotyledon	Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush	h	1	1	1		1		1	1	1
Dicotyledon	Chenopodiaceae		*Enchylaena tomentosa*	Ruby Saltbush	ss								1	
Dicotyledon	Chenopodiaceae		*Maireana brevifolia*	Yanga Bush	s									
Dicotyledon	Chenopodiaceae		*Maireana enchylaenoides*	Wingless Fissure Weed	h					1		1		
Dicotyledon	Chenopodiaceae		*Maireana excavata*	Bottle Bluebush	ss									
Dicotyledon	Chenopodiaceae		*Maireana microphylla*	Eastern Cottonbush	ss		1				1			
Dicotyledon	Chenopodiaceae		*Maireana sp.*		ss				1					
Dicotyledon	Chenopodiaceae		*Maireana villosa?*	Blue Pearlbush	ss									
Dicotyledon	Chenopodiaceae		*Salsola kali*	Buckbush	ss								1	
Dicotyledon	Chenopodiaceae		*Sclerolaena diacantha*	Grey Copperburr	ss						1		1	1
Dicotyledon	Chenopodiaceae		*Sclerolaena muricata*	Black Roly Poly	ss	1	1			1				
Dicotyledon	Chenopodiaceae		*Sclerolaena sp.*		ss									
Dicotyledon	Convolvulaceae		*Convolvulus erubescens*	Australian Bindweed	h		1	1	1	1	1	1	1	1
Dicotyledon	Convolvulaceae		*Dichondra repens*	Kidney Weed	h	1	1	1	1	1	1	1	1	1
Dicotyledon	Crassulaceae		*Crassula colorata*	Dense Stonecrop	h									
Dicotyledon	Euphorbiaceae		*Chamaesyce drummondii*	Caustic Weed	h						1			
Dicotyledon	Fabaceae (Caesalpinoideae)		*Senna artemisioides nothosubsp. artemisoides*	Silver Cassia	s									
Dicotyledon	Fabaceae (Caesalpinoideae)		*Senna artemisioides subsp filifolia*	Punty Bush	s								1	
Dicotyledon	Fabaceae (Faboideae)		*Glycine clandestina*	Climbing Glycine	h				1	1			1	
Dicotyledon	Fabaceae (Faboideae)		*Glycine sp.*	Glycine	h			1	1			1		
Dicotyledon	Fabaceae (Faboideae)		*Glycine tabacina*	Variable Glycine	h									1
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago minima*	Small Woolly Burr Medic	h				1			1		
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago polymorpha*	Burr Medic	h		1					1		1
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago sativa*	Lucerne	h									
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago sp.*	A Medic	h									
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago truncatula*	Barrel Medic	h	1	1			1				
Dicotyledon	Fabaceae (Faboideae)	*	*Melilotus indicus*	Hexham Scent	h									
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium angustifolium*	Narrow-leaf Clover	h	1	1					1		
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium arvense*	Haresfoot Clover	h	1	1	1	1					1
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium campestre*	Hop Clover	h	1	1	1		1				
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium glomeratum*	Clustered Clover	h	1	1	1						

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium hirtum*	Rose Clover	h									
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium incarnatum*	Crimson Clover	h									
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium subterraneum*	Subterraneum Clover	h	1	1	1						
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium tomentosum*	Woolly Clover	h	1								
Dicotyledon	Fabaceae (Faboideae)	*	*Vicia villosa*	Vetch	h									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia brachstachya*	Umbrella Mulga	s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia deanei*	Green Wattle	s							1		
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia decora*	Western Golden Wattle	s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia hakeoides*	Hakea Wattle	s						1		1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia leucoclada*		s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia pendula*	Myall	s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia spectabilis*	Mudgee Wattle	s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia stenophylla*	River Cooba	s									
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia trineura*	Three-nerved Wattle	s									
Dicotyledon	Fumariaceae	*	*Fumaria densiflora*	Dense-flowered Fumitory	h									
Dicotyledon	Gentaniaceae	*	*Centaurium erythraea*	Common Centaury	h			1		1				
Dicotyledon	Geraniaceae		*Erodium crinitum*	Blue Storksbill	h			1						
Dicotyledon	Geraniaceae		*Geranium solanderi*	Native Geranium	h									
Dicotyledon	Goodeniaceae		*Goodenia hederacea*	Forest Goodenia	h							1	1	
Dicotyledon	Goodeniaceae		*Goodenia pinnatifida*	Scrambled Eggs	h					1	1	1	1	1
Dicotyledon	Goodeniaceae		*Goodenia pusilliflora*	Small-flowered Goodenia	h									
Dicotyledon	Lamiaceae	*	*Marrubium vulgare*	Horehound	h						1	1		1
Dicotyledon	Lamiaceae		*Mentha satureioides*	Native Pennyroyal	h									
Dicotyledon	Lamiaceae	*	*Salvia verbenaca*	Wild Sage	h	1		1	1	1	1	1		1
Dicotyledon	Lamiaceae		*Scutellaria humilis*	Dwarf Scullcap	h						1			
Dicotyledon	Linaceae		*Linum marginale*	Native Flax	h									
Dicotyledon	Lobeliaceae		*Pratia concolor*	Poison Pratia	h									
Dicotyledon	Malvaceae	*	*Malva parviflora*	Small-flowered Mallow	h									
Dicotyledon	Malvaceae		*Sida corrugata*	Corrugated Sida	h			1	1	1			1	1
Dicotyledon	Malvaceae		*Sida cunninghamii*	Ridge Sida	h						1	1	1	
Dicotyledon	Malvaceae		*Sida fibulifera*	Pin Sida	h									
Dicotyledon	Malvaceae		*Sida sp.*		h					1				1
Dicotyledon	Malvaceae		*Sida trichopoda*	Hairy Sida	h									
Dicotyledon	Myoporaceae		*Eremophila debilis*	Amulla	ss				1		1		1	

Group	Family	exotic	Scientific Name	Common Name	Habit	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	RWood01	RWood02	RWood03	RWood04
Dicotyledon	Myrtaceae	*	*Corymbia citriodora*	Lemon-scented Gum	t									
Dicotyledon	Myrtaceae		*Eucalyptus albens*	White Box	t							1		
Dicotyledon	Myrtaceae		*Eucalyptus camaldulensis*	River Red Gum	t									
Dicotyledon	Myrtaceae		*Eucalyptus dwyeri*	Dwyer's Red Gum	t									
Dicotyledon	Myrtaceae		*Eucalyptus largiflorens*	Black Box	t									
Dicotyledon	Myrtaceae		*Eucalyptus melliodora*	Yellow Box	t									1
Dicotyledon	Myrtaceae		*Eucalyptus microcarpa*	Grey Box	t						1		1	
Dicotyledon	Myrtaceae		*Eucalyptus populnea*	Bimble Box	t							1		1
Dicotyledon	Myrtaceae		*Eucalyptus sideroxylon*	Mugga Ironbark	t									
Dicotyledon	Myrtaceae		*Eucalyptus viridis*	Green Mallee	t									
Dicotyledon	Nyctaginaceae		*Boerhavia dominii*	Tar Vine	h						1			1
Dicotyledon	Onagraceae		*Epilobium billardierianum*	Willow Herb	h									
Dicotyledon	Onagraceae		*Epilobium sp.*	Willow Herb	h									
Dicotyledon	Oxalidaceae		*Oxalis perennans*	Yellow Wood-sorrel	h	1				1	1	1		1
Dicotyledon	Papaveraceae	*	*Papaver hybridum*	Rough Poppy	h									
Dicotyledon	Papaveraceae	*	*Papaver somniferum*	Opium Poppy	h									
Dicotyledon	Pittosporaceae		*Pittosporum angustifolium*	Butterbush	s									
Dicotyledon	Plantaginaceae	*	*Echium plantagineum*	Paterson's Curse	h	1	1	1	1	1	1			1
Dicotyledon	Plantaginaceae		*Plantago debilis*	Plantain	h								1	
Dicotyledon	Polygonaceae		*Rumex brownii*	Swamp Dock	h	1	1			1				1
Dicotyledon	Polygonaceae	*	*Rumex crispus*	Curled Dock	h									
Dicotyledon	Polygonaceae		*Rumex tenax*	Shiny Dock	h		1							
Dicotyledon	Primulaceae	*	*Anagellis arvensis*	Scarlet Pimpernel	h									
Dicotyledon	Ranunculaceae		*Ranunculus sessiliflorus var. sessiliflorus*	Small-flowered Buttercup	h							1		
Dicotyledon	Rubiaceae		*Asperula conferta*	Common Woodruff	h	1		1	1					
Dicotyledon	Sapindaceae		*Alectryon oleifolius*	Rosewood	t						1			
Dicotyledon	Sapindaceae		*Dodonaea boroniifolia*	Fern-leaf Hopbush	s									
Dicotyledon	Sapindaceae		*Dodonaea viscosa subsp. cuneata*	Wedge-leaf Hopbush	s				1		1		1	
Dicotyledon	Schrophulariaceae	*	*Verbascum virgatum*	Twiggy Mullein	h									
Dicotyledon	Solanaceae		*Solanum cinereum*	Narrawa Burr	h				1					
Dicotyledon	Solanaceae		*Solanum esuriale*	Quena	h					1	1			1
Dicotyledon	Sterculiaceae		*Brachychiton populneus*	Kurrajong	t									
Dicotyledon	Verbenaceae	*	*Verbena officinalis*	Common Verbena	h									
Coniferopsida	Cupressaceae		*Callitris glaucophylla*	White Cypress Pine	t	1	1	1	1	1	1	1		1

Appendix 2. ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT– Estcourt Offset Sites

Soil samples supplied by DNA Environmental on 22nd October, 2012 - Lab Job No. C2772

				Site	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	***Heavy Soil*** *e.g Clay*	***Medium Soil*** *e.g Clay Loam*	***Light Soil*** *e.g Loam*	***Sandy Soil*** *e.g Loamy Sand*
	Method	*Nutrient*		*Units*	*C2772/22*	*C2772/23*	*C2772/24*	*C2772/25*	*C2772/26*	***Indicative guidelines only- refer Note 6***			
	Morgan 1	Calcium	Ca	mg/kg	552	614	812	1235	795	*1150*	*750*	*375*	*175*
		Magnesium	Mg		282	254	174	205	224	*160*	*105*	*60*	*25*
		Potassium	K		315	374	304	243	289	*113*	*75*	*60*	*50*
		Phosphorus	P		3.3	3.2	3.5	3.6	2.3	*15*	*12*	*10*	*5.0*
	Bray1	Phosphorus	P	mg/kg	24.8	15.8	5.9	5.2	4.6	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
	Colwell				60	44	15	16	16	*80*	*50*	*45*	*35*
	Bray2				51	30	13	12	9	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	KCl	Nitrate Nitrogen	N	mg/kg	2.2	2.3	3.8	5.6	4.5	*15*	*13*	*10*	*10*
		Ammonium Nitrogen			4.5	38.4	19.4	6.5	8.7	*20*	*18*	*15*	*12*
		Sulfur	S		4.4	6.8	9.2	10.6	7.9	*10.0*	*8.0*	*8.0*	*7.0*
	1:5 Water	pH		units	6.22	6.24	6.40	6.16	6.14	*6.5*	*6.5*	*6.3*	*6.3*
		Conductivity		dS/m	0.067	0.094	0.070	0.078	0.057	*0.200*	*0.150*	*0.120*	*0.100*
	Calculation	Organic Matter		% OM	3.3	3.9	5.2	7.8	4.8	*>5.5*	*>4.5*	*>3.5*	*>2.5*
	Ammonium Acetate + Calculations	Calcium	Ca	$cmol^+/Kg$	5.29	5.59	7.41	12.24	7.42				
				kg/ha	2375	2507	3325	5495	3329				
				mg/kg	1060	1119	1484	2453	1486	*3125*	*2150*	*1000*	*375*
		Magnesium	Mg	$cmol^+/Kg$	3.72	3.26	2.07	2.68	2.85				
				kg/ha	1013	887	564	730	776				
				mg/kg	452	396	252	326	346	*290*	*200*	*145*	*75*

				Site	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	*Heavy Soil* e.g	*Medium Soil* e.g Clay Loam	*Light Soil* e.g Loam	*Sandy Soil* e.g Loamy
		Potassium	K	cmol+/Kg	1.82	2.04	1.46	1.42	1.62				
				kg/ha	1594	1787	1281	1240	1419				
				mg/kg	711	798	572	554	634	*235*	*190*	*150*	*100*
		Sodium	Na	cmol+/Kg	0.40	0.32	0.04	0.03	0.08				
				kg/ha	205	167	22	17	39				
				mg/kg	92	74	10	8	17	*69*	*60*	*51*	*25*
	KCl	Aluminium	Al	cmol+/Kg	0.02	0.02	0.02	0.02	0.02				
				kg/ha	4	3	4	3	3				
				mg/kg	2	2	2	2	2	*54*	*45*	*41*	*14*
	Acidity Titration	Hydrogen	H^+	cmol+/Kg	0.17	0.20	0.14	0.22	0.17				
				kg/ha	4	5	3	5	4				
				mg/kg	2	2	1	2	2	*6*	*5*	*5*	*2*
	Calculation	Effective Cation Exchange Capacity (ECEC)		cmol+/Kg	11.42	11.43	11.14	16.61	12.15	*20*	*14*	*7*	*4*
		Exchangeable Sodium Percentage		%	3.49	2.83	0.38	0.20	0.62				
	Base Saturation Calculations	Calcium	Ca	%	46.3	48.9	66.5	73.7	61.0	*77*	*76*	*69*	*60*
		Magnesium	Mg		32.6	28.5	18.6	16.1	23.4	*12*	*12*	*16*	*20*
		Potassium	K		15.9	17.9	13.1	8.5	13.3	*3*	*4*	*5*	*8*
		Sodium - ESP	Na		3.5	2.8	0.4	0.2	0.6	*2*	*2*	*3*	*3*
		Aluminium	Al		0.2	0.1	0.2	0.1	0.1	*7*	*7*	*7*	*9*
		Hydrogen	H^+		1.5	1.8	1.3	1.3	1.4				
	Calculation	Calcium/ Magnesium Ratio		ratio	1.4	1.7	3.6	4.6	2.6	*6.4*	*6.3*	*4.3*	*3.0*
	DTPA	Zinc	Zn	mg/kg	1.1	1.4	1.4	3.8	1.5	*6.0*	*5.0*	*4.0*	*3.0*
		Manganese	Mn		75	87	40	142	92	*25*	*22*	*18*	*15*
		Iron	Fe		101	103	60	87	98	*25*	*22*	*18*	*15*

				Site	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	*Heavy Soil* e.g	*Medium Soil* e.g Clay Loam	*Light Soil* e.g Loam	*Sandy Soil* e.g Loamy
		Copper	Cu		4.3	5.9	6.4	9.3	4.8	*2.4*	*2.0*	*1.6*	*1.2*
$CaCl_2$		Boron	B	mg/kg	0.79	0.76	0.51	0.57	0.61	*2.0*	*1.7*	*1.4*	*1.0*
		Silicon	Si		97	95	74	71	70	*50*	*45*	*40*	*35*
LECO IR Analyser		Total Carbon	C	%	1.91	2.23	2.95	4.48	2.74	*>3.1*	*>2.6*	*>2.0*	*>1.4*
		Total Nitrogen	N	%	0.14	0.18	0.26	0.33	0.23	*>0.30*	*>0.25*	*>0.20*	*>0.15*
Calculation		Carbon/ Nitrogen Ratio		ratio	13.9	12.7	11.2	13.5	12.1	*10-12*	*10-12*	*10-12*	*10-12*
		Basic Texture			Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	..	..	..	..
		Basic Colour			Brownish	Brownish	Brownish	Brownish	Brownish	..	..	..	..
Calculation		Chloride Estimate		equiv. ppm	43	60	45	50	37	..	..	..	..
Total Acid Extractable		Calcium	Ca	mg/kg	1,346	1,532	2,084	3,354	1,988	*1,000 - 10,000 Ca*			
		Magnesium	Mg		1,098	1,165	951	1,319	1,061	*500 - 5,000 Mg*			
		Potassium	K		1,996	2,332	2,280	2,545	2,105	*200 - 2,000 K*			
		Sodium	Na		142	133	<50	<50	<50	*100 - 500 Na*			
		Sulfur	S		140	156	232	291	197	*100 - 1,000 S*			
Total Acid Extractable		Phosphorus	P	mg/kg	339	339	462	393	308	*400 - 1,500 P*			
Total Acid Extractable		Zinc	Zn	mg/kg	20	28	29	56	28	*20 - 50 Zn*			
		Manganese	Mn		938	998	464	1,766	1,070	*200 - 2,000 Mn*			
		Iron	Fe		20,252	20,209	39,810	30,853	24,457	*1,000 - 50,000 Fe*			
		Copper	Cu		31.2	43.2	97.2	80.2	36.3	*20 - 50 Cu*			
		Boron	B		3.5	3.8	3.2	3.9	3.5	*2 - 50 B*			
		Silicon	Si		960	1,073	1,029	1,429	1,128	*1,000 - 3,000 Si*			
		Aluminium	Al		12,193	13,604	12,216	17,418	13,215	*2,000 - 50,000 Al*			
Total Acid Extractable		Molybdenum	Mo	mg/kg	0.8	0.9	2.2	1.3	0.8	*0.5 - 3 Mo*			
		Cobalt	Co		9.1	10	7.1	13	8.8	*5 - 50 Co*			

			Site	EOA-01	EOA-02	EOA-03	EOA-04	EOA-05	*Heavy Soil*	*Medium Soil e.g*	*Light Soil e.g*	*Sandy Soil e.g*
	Selenium	Se		<0.5	0.7	2.3	0.7	0.6	*0.1 - 2.0 Se*			
Total Acid Extractable	Cadmium	Cd	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	*< 5 Cd*			
	Lead	Pb		11	11	8.9	16	12	*< 75 Pb*			
	Arsenic	As		3.1	3.0	12	3.6	3.1	*< 25 As*			
	Chromium	Cr		22	25	17	24	27	*<25 Cr*			
	Nickel	Ni		7.1	8.4	5	11	8.2	*<150 Ni*			
	Mercury	Hg		<0.1	<0.1	<0.1	<0.1	<0.1	*< 3.75 Hg*			
	Silver	Ag		<1	<1	<1	<1	<1	*.. Ag*			

EAL Soil Testing Notes

1. All results as dry weight - 40°C oven dried soil crushed to <2mm

2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*

3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH

4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.

5. Guidelines for phosphorus have been reduced for Australian soils

6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts

7. Total Acid Extractable Nutrients indicate a store of nutrients

8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).

9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm

2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm

3. Conversions for 1 $cmol^+$/Kg = 230 Kg/Hectare Sodium, 780 Kg/Ha Potassium, 240 Kg/Ha Magnesium, 400 Kg/Ha Calcium

4. Organic Matter = %C x 1.75

5. Chloride Estimate = EC x 640 (most likely over-estimate)

6. ECEC = sum of the exchangeable cations $cmol^+$/Kg

7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100

8. Ca/Mg ratio from the exchangeable $cmol^+$/Kg results

Appendix 3. ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT– Reference Sites

Soil samples supplied by DNA Environmental on 22nd October, 2012 - Lab Job No. C2772

				Site	RWood01	RWood02	RWood03	RWood04	***Heavy Soil** e.g Clay*	***Medium Soil** e.g Clay Loam*	***Light Soil** e.g Loam*	***Sandy Soil** e.g Loamy Sand*
Method		*Nutrient*		*Units*	*C2772/15*	*C2772/16*	*C2772/17*	*C2772/18*	***Indicative guidelines only- refer Note 6***			
	Morgan 1	Calcium	Ca	mg/kg	909	1347	777	1113	*1150*	*750*	*375*	*175*
		Magnesium	Mg		350	378	395	283	*160*	*105*	*60*	*25*
		Potassium	K		273	204	199	349	*113*	*75*	*60*	*50*
		Phosphorus	P		3.7	3.2	2.7	3.2	*15*	*12*	*10*	*5.0*
	Bray1	Phosphorus	P	mg/kg	10.9	6.4	7.6	4.1	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
	Colwell				24	20	16	14	*80*	*50*	*45*	*35*
	Bray2				23	23	14	10	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	KCl	Nitrate Nitrogen	N	mg/kg	2.8	4.5	2.7	7.3	*15*	*13*	*10*	*10*
		Ammonium Nitrogen			3.6	4.0	3.6	8.8	*20*	*18*	*15*	*12*
		Sulfur	S		9.2	8.5	6.9	8.4	*10.0*	*8.0*	*8.0*	*7.0*
	1:5 Water	pH		units	6.48	6.87	6.56	6.48	*6.5*	*6.5*	*6.3*	*6.3*
		Conductivity		dS/m	0.056	0.055	0.055	0.077	*0.200*	*0.150*	*0.120*	*0.100*
	Calculation	Organic Matter		% OM	5.3	5.3	4.3	6.3	*>5.5*	*>4.5*	*>3.5*	*>2.5*
	Ammonium Acetate + Calculations	Calcium	Ca	cmol+/Kg	8.64	12.75	7.47	11.04				
				kg/ha	3880	5722	3352	4956				
				mg/kg	1732	2554	1496	2212	*3125*	*2150*	*1000*	*375*
		Magnesium	Mg	cmol+/Kg	4.56	5.04	5.22	3.73				
				kg/ha	1243	1371	1421	1016				
				mg/kg	555	612	634	454	*290*	*200*	*145*	*75*

				Site	RWood01	RWood02	RWood03	RWood04	*Heavy Soil e.g Clay*	*Medium Soil e.g Clay Loam*	*Light Soil e.g Loam*	*Sandy Soil e.g Loamy*
	Potassium	K	cmol+/Kg		1.66	1.21	1.14	2.01				
			kg/ha		1453	1058	997	1762				
			mg/kg		648	472	445	787	*235*	*190*	*150*	*100*
	Sodium	Na	cmol+/Kg		0.22	0.05	0.24	0.03				
			kg/ha		114	28	126	14				
			mg/kg		51	13	56	6	*69*	*60*	*51*	*25*
KCl	Aluminium	Al	cmol+/Kg		0.00	0.01	0.01	0.01				
			kg/ha		1	2	2	2				
			mg/kg		0	1	1	1	*54*	*45*	*41*	*14*
Acidity Titration	Hydrogen	H^+	cmol+/Kg		0.18	0.00	0.00	0.16				
			kg/ha		4	0	0	4				
			mg/kg		2	0	0	2	*6*	*5*	*5*	*2*
Calculation	Effective Cation Exchange Capacity (ECEC)		cmol+/Kg		15.28	19.06	14.08	16.99	*20*	*14*	*7*	*4*
	Exchangeable Sodium Percentage		%		1.45	0.29	1.74	0.16				
Base Saturation Calculations	Calcium	Ca	%		56.6	66.9	53.0	65.0	*77*	*76*	*69*	*60*
	Magnesium	Mg			29.9	26.4	37.1	22.0	*12*	*12*	*16*	*20*
	Potassium	K			10.9	6.3	8.1	11.8	*3*	*4*	*5*	*8*
	Sodium - ESP	Na			1.5	0.3	1.7	0.2	*2*	*2*	*3*	*3*
	Aluminium	Al			0.0	0.1	0.1	0.1	*7*	*7*	*7*	*9*
	Hydrogen	H^+			1.2	0.0	0.0	1.0				
Calculation	Calcium/ Magnesium Ratio		ratio		1.9	2.5	1.4	3.0	*6.4*	*6.3*	*4.3*	*3.0*
DTPA	Zinc	Zn	mg/kg		2.0	1.5	1.2	11.9	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese	Mn			202	46	62	104	*25*	*22*	*18*	*15*
	Iron	Fe			65	39	45	52	*25*	*22*	*18*	*15*

				Site	RWood01	RWood02	RWood03	RWood04	*Heavy Soil e.g Clay*	*Medium Soil e.g Clay Loam*	*Light Soil e.g Loam*	*Sandy Soil e.g Loamy*
		Copper	Cu		4.7	12.2	4.1	23.2	*2.4*	*2.0*	*1.6*	*1.2*
$CaCl_2$		Boron	B	mg/kg	0.84	0.71	0.73	0.86	*2.0*	*1.7*	*1.4*	*1.0*
		Silicon	Si		58	70	59	73	*50*	*45*	*40*	*35*
LECO IR Analyser		Total Carbon	C	%	3.05	3.04	2.46	3.62	*>3.1*	*>2.6*	*>2.0*	*>1.4*
		Total Nitrogen	N	%	0.20	0.22	0.16	0.30	*>0.30*	*>0.25*	*>0.20*	*>0.15*
Calculation		Carbon/ Nitrogen Ratio		ratio	15.0	13.6	15.1	12.1	*10-12*	*10-12*	*10-12*	*10-12*
		Basic Texture			Clay Loam	Clay Loam	Clay Loam	Clay Loam	..	..	..	..
		Basic Colour			Brownish	Brownish	Brownish	Brownish	..	..	..	..
Calculation		Chloride Estimate		equiv. ppm	36	35	35	49	..	..	..	..
Total Acid Extractable		Calcium	Ca	mg/kg	2,367	4,045	1,978	3,291	*1,000 - 10,000 Ca*			
		Magnesium	Mg		1,396	3,011	1,398	2,965	*500 - 5,000 Mg*			
		Potassium	K		2,368	2,531	1,660	3,329	*200 - 2,000 K*			
		Sodium	Na		111	91	109	<50	*100 - 500 Na*			
		Sulfur	S		212	213	172	263	*100 - 1,000 S*			
Total Acid Extractable		Phosphorus	P	mg/kg	363	337	240	430	*400 - 1,500 P*			
Total Acid Extractable		Zinc	Zn	mg/kg	36	50	29	223	*20 - 50 Zn*			
		Manganese	Mn		3,740	948	856	2,176	*200 - 2,000 Mn*			
		Iron	Fe		19,367	57,764	19,212	41,505	*1,000 - 50,000 Fe*			
		Copper	Cu		39.6	101.3	35.2	162.9	*20 - 50 Cu*			
		Boron	B		4.2	5.0	4.1	3.9	*2 - 50 B*			
		Silicon	Si		1,125	1,056	1,234	1,221	*1,000 - 3,000 Si*			
		Aluminium	Al		16,085	19,556	13,731	21,992	*2,000 - 50,000 Al*			
Total Acid Extractable		Molybdenum	Mo	mg/kg	0.6	<0.5	<0.5	1.0	*0.5 - 3 Mo*			
		Cobalt	Co		15	18	7	16	*5 - 50 Co*			

			Site	RWood01	RWood02	RWood03	RWood04	*Heavy Soil e.g Clay*	*Medium Soil e.g Clay Loam*	*Light Soil e.g Loam*	*Sandy Soil e.g Loamy*
	Selenium	Se		0.8	0.8	<0.5	0.8	*0.1 - 2.0 Se*			
Total Acid Extractable	Cadmium	Cd	mg/kg	<0.5	<0.5	<0.5	<0.5	*< 5 Cd*			
	Lead	Pb		13	9.2	13	17	*< 75 Pb*			
	Arsenic	As		3.5	3.9	3.1	7.3	*< 25 As*			
	Chromium	Cr		23	111	22	22	*<25 Cr*			
	Nickel	Ni		10	25	8.4	11	*<150 Ni*			
	Mercury	Hg		<0.1	<0.1	<0.1	<0.1	*< 3.75 Hg*			
	Silver	Ag		<1	<1	<1	<1	*.. Ag*			

EAL Soil Testing Notes

1. All results as dry weight - 40°C oven dried soil crushed to <2mm

2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*

3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH

4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.

5. Guidelines for phosphorus have been reduced for Australian soils

6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts

7. Total Acid Extractable Nutrients indicate a store of nutrients

8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).

9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm

2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm

3. Conversions for 1 $cmol^+$/Kg = 230 Kg/Hectare Sodium, 780 Kg/Ha Potassium, 240 Kg/Ha Magnesium, 400 Kg/Ha Calcium

4. Organic Matter = %C x 1.75

5. Chloride Estimate = EC x 640 (most likely over-estimate)

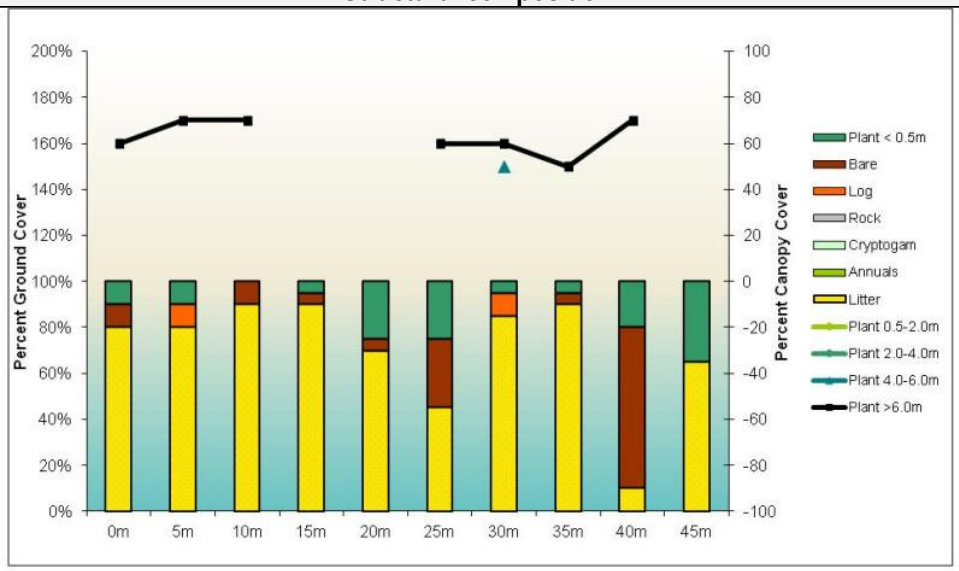
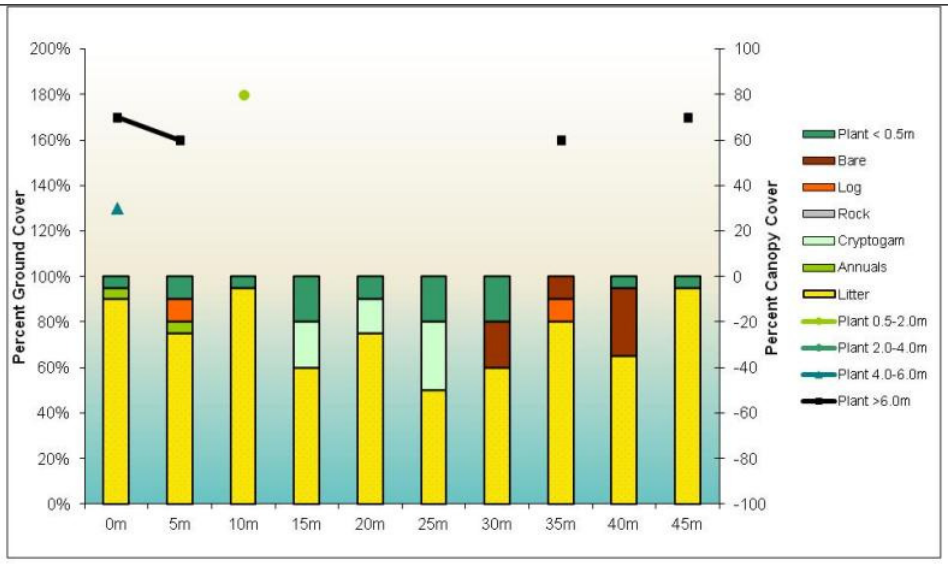
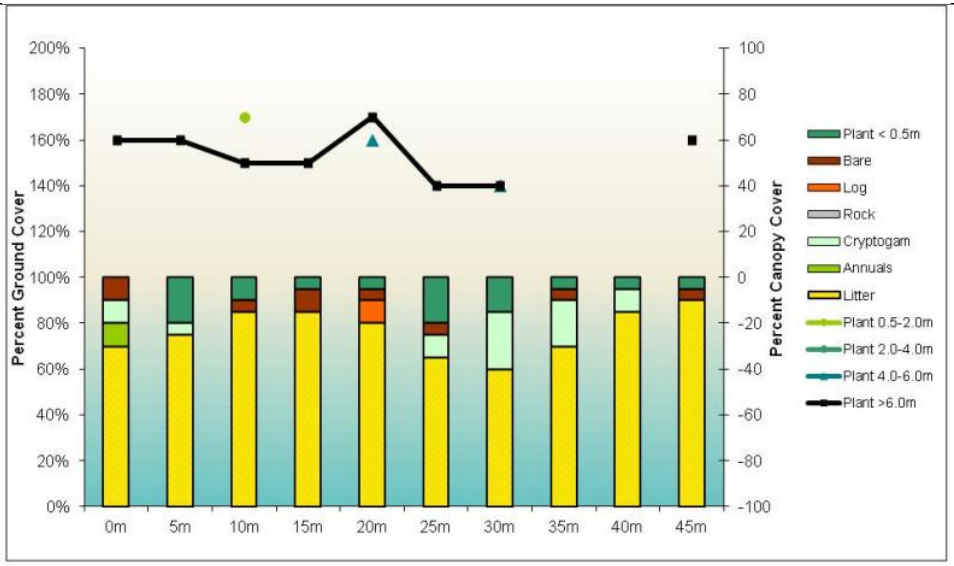
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg

7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100

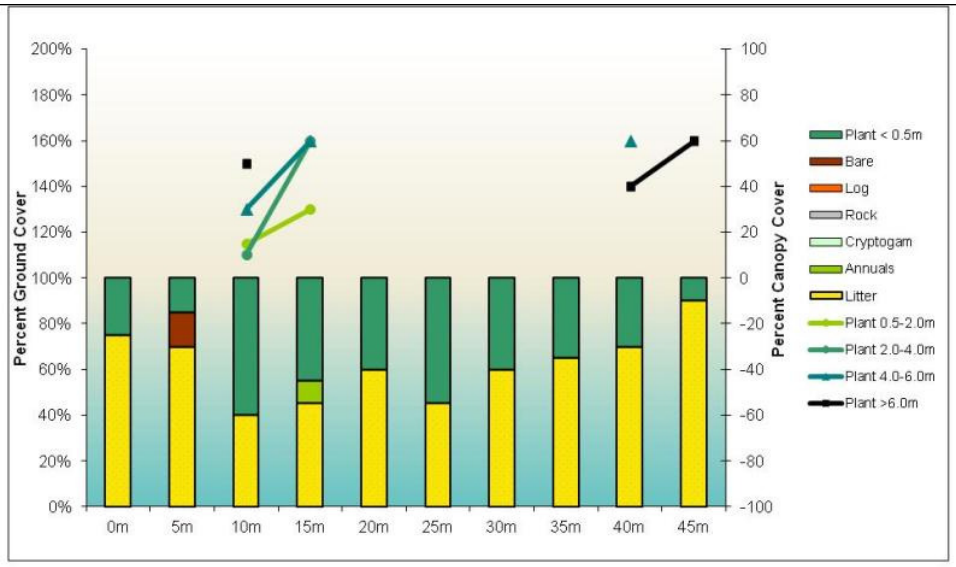
8. Ca/Mg ratio from the exchangeable $cmol^+$/Kg results

Appendix 4. Data obtained from the woodland reference sites 2012

Site	Vegetation transect (front)	Vegetation transect (rear)
RWood01		
RWood02		
RWood03		
RWood04		

Site	Structural composition
RWood01	
RWood02	
RWood03	

RWood04

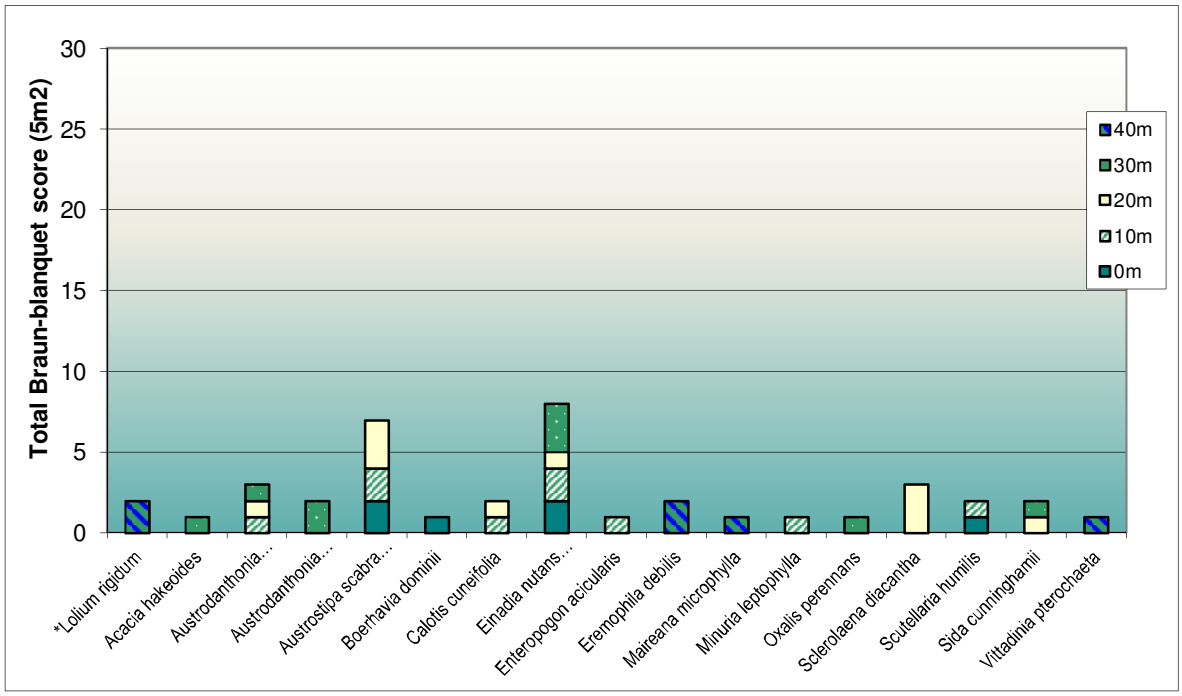


Landscape Function Analysis

Site		RWood01		RWood02		RWood03		16/10/2012	
Number of Patches/10m		0.5		0.5		0.5		0.5	
Total Patch Area (m2)		200.00		200.00		200.00		200.00	
Patch Area Index		1.00		1.00		1.00		1.00	
Landscape Organisation Index		1.00		1.00		1.00		1.00	
Average Interpatch Length (m)		NA		Nil		NA		NA	
Range Interpatch length (m)		NA		Nil		NA		NA	
Patch or Interpatch Type		Woodland Patch		Woodland Patch		Woodland Patch		Woodland Patch	
Patch or Interpatch Proportion (%)		100.0	**100**	100.0	**100**	100.0	**100**	100.0	**100**
Soil Surface Assessment									
Within Individual Zones	Stability	63.5		69.4		70.9		71.0	
	Infiltration	44.4		52.8		46.8		45.4	
	Nutrients	40.9		51.6		48.1		41.8	
			Total		Total		Total		Total
Individual zones contribution to the whole of Landscape	Stability	63.5	**63.5**	69.4	**69.4**	70.9	**70.9**	71.0	**71.0**
	Infiltration	44.4	**44.4**	52.8	**52.8**	46.8	**46.8**	45.4	**45.4**
	Nutrients	40.9	**40.9**	51.6	**51.6**	48.1	**48.1**	41.8	**41.8**

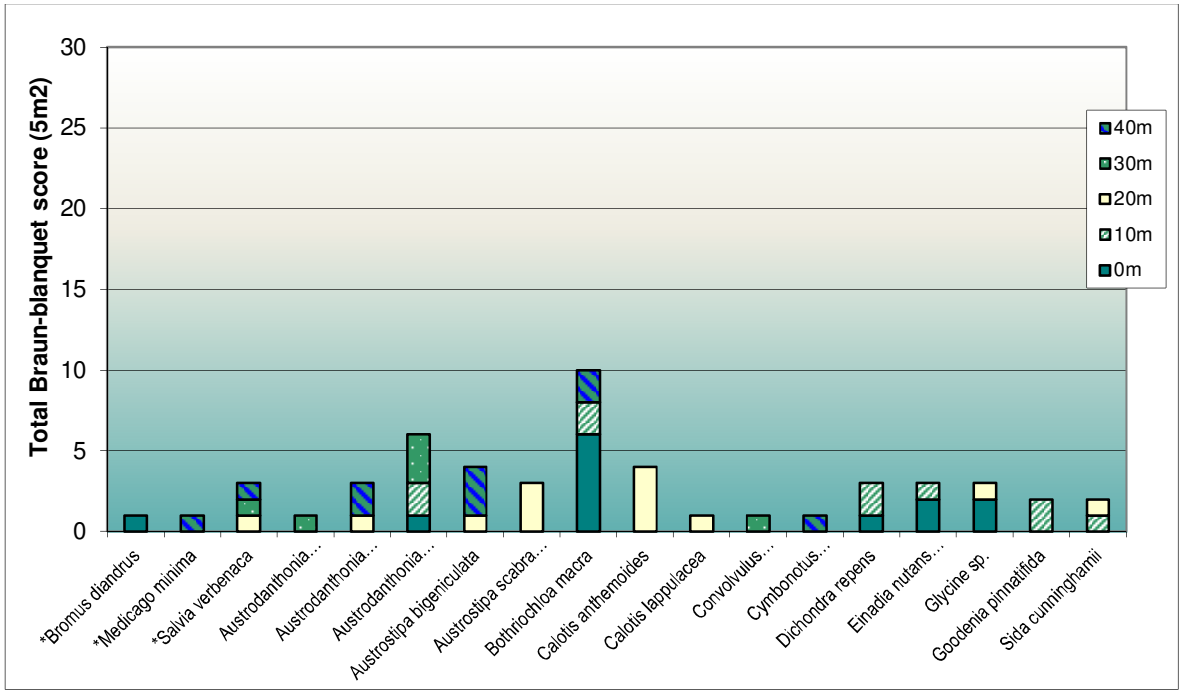
Species cover abundance

RWood01



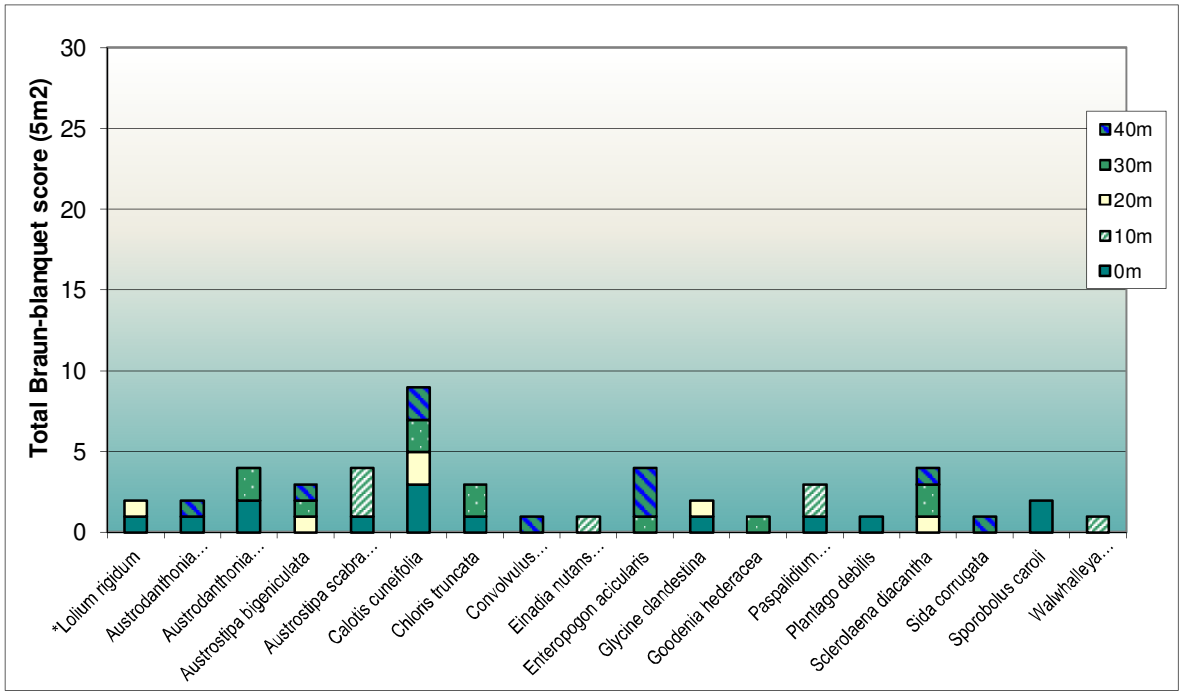
Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	4	7	6	6	3	**5.2**	1.6
Exotic	0	0	0	0	1	**0.2**	0.4
Total	**4**	**7**	**6**	**6**	**4**	**5.4**	1.3

RWood02



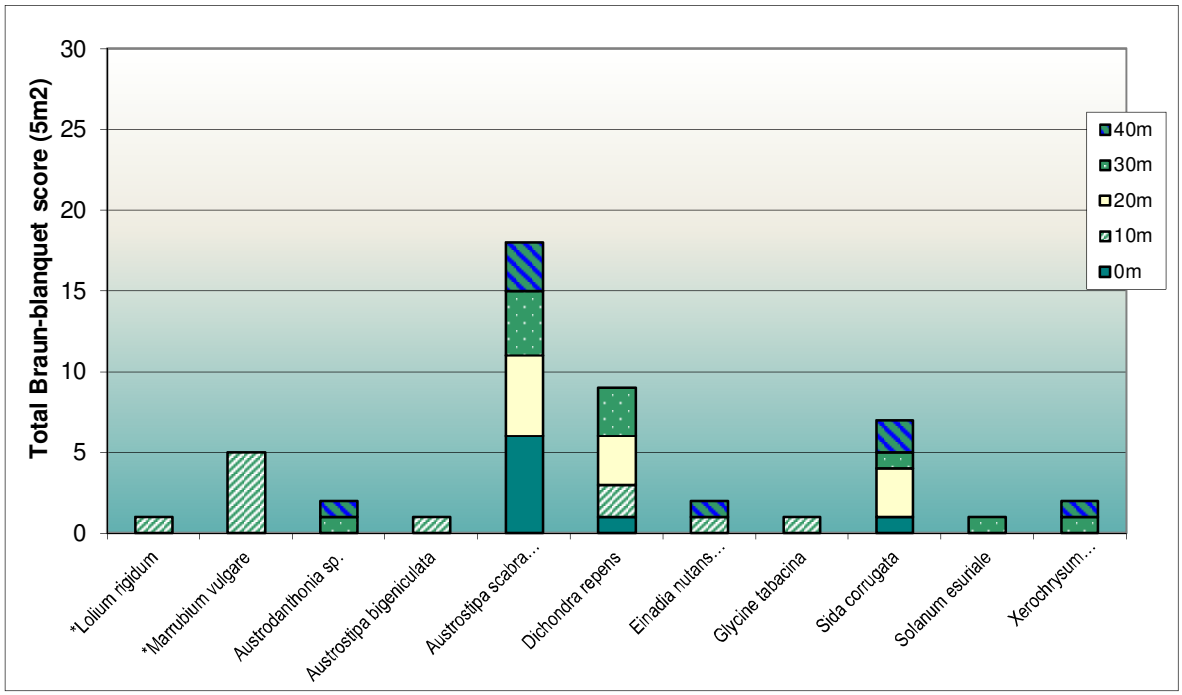
Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	5	6	7	3	4	**5**	1.6
Exotic	1	0	1	1	2	**1**	0.7
Total	**6**	**6**	**8**	**4**	**6**	**6**	1.4

RWood03



Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	9	4	4	7	7	**6.2**	2.2
Exotic	1	0	1	0	0	**0.4**	0.5
Total	**10**	**4**	**5**	**7**	**7**	**6.6**	2.3

RWood04

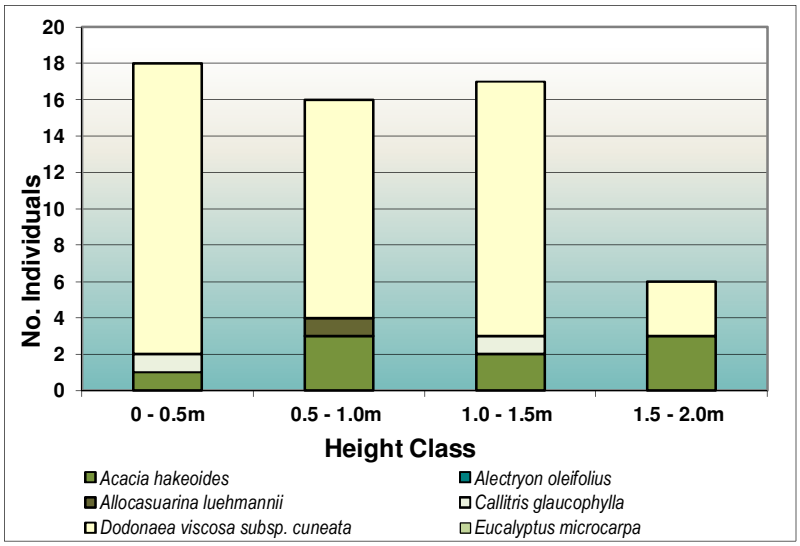


Species /m2	0m	10m	20m	30m	40m	Avg/m2	SD
Native	3	4	3	6	5	**4.2**	1.3
Exotic	0	2	0	0	0	**0.4**	0.9
Total	**3**	**6**	**3**	**6**	**5**	**4.6**	1.5

Trees and Shrubs

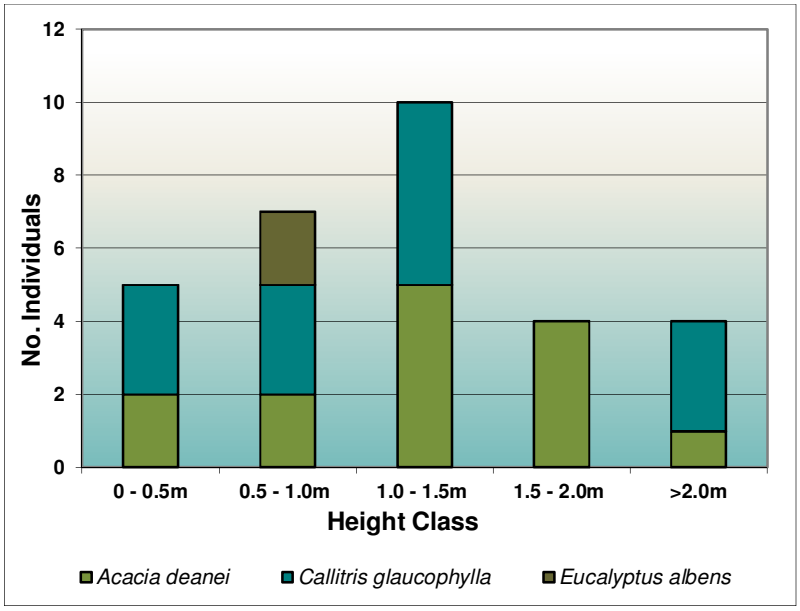
RWood01

Dominant species	*Eucalyptus microcarpa (6), Allocasuarina luehmannii (5), Acacia hakeoides (1)*
Average dbh (Cm)	38
Max dbh (cm)	76
Min dbh (cm)	12
Total trees	12
No. with multiple limbs	0
No. Live trees	12
No. Healthy	1
No. Medium Health	9
No. Advanced Dieback	2
No. Dead	0
Mistletoe	0
Flowers / fruit	7



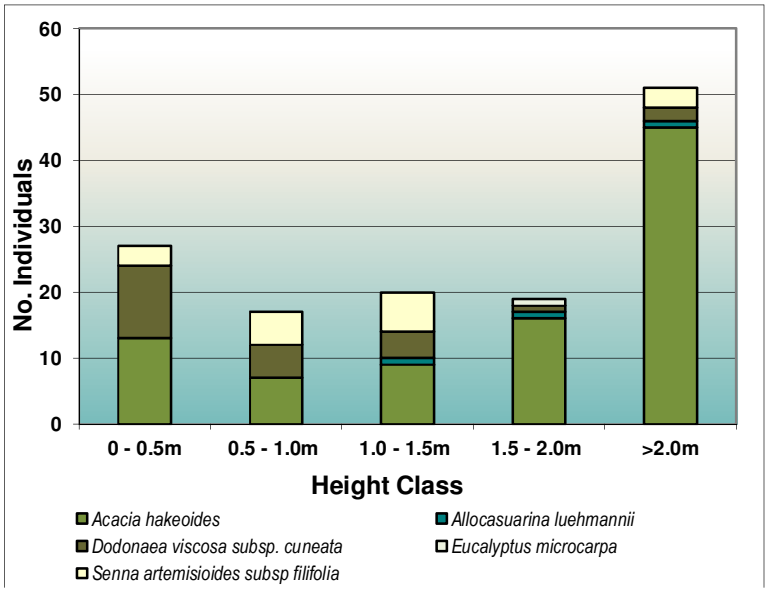
RWood02

Dominant species	*Callitris glaucophylla (13), Eucalyptus albens (5), Eucalyptus populnea (1)*
Average dbh (Cm)	18
Max dbh (cm)	49
Min dbh (cm)	5
Total trees	19
No. with multiple limbs	1
No. Live trees	19
No. Healthy	8
No. Medium Health	10
No. Advanced Dieback	1
No. Dead	0
Mistletoe	0
Flowers / fruit	11



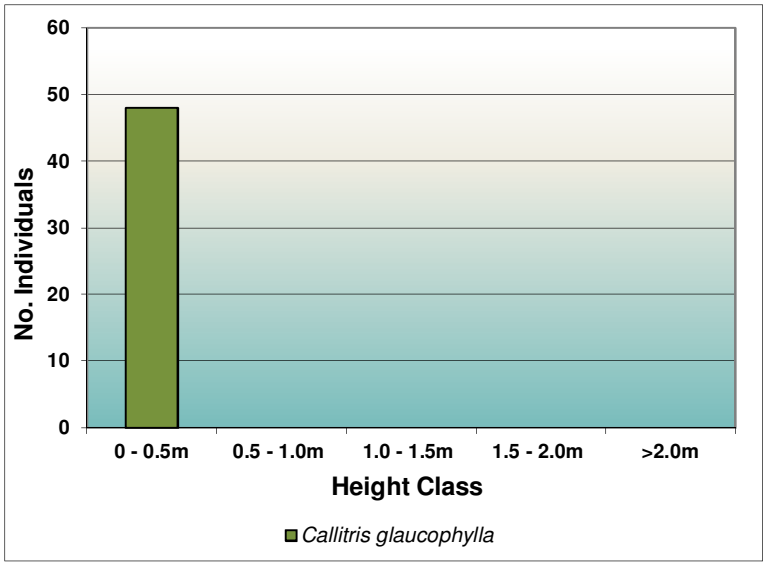
RWood03

Dominant species	*Eucalyptus microcarpa (6), Acacia hakeoides (2), Allocasuarina luehmannii (1)*
Average dbh (Cm)	37
Max dbh (cm)	66
Min dbh (cm)	6
Total trees	9
No. with multiple limbs	0
No. Live trees	9
No. Healthy	0
No. Medium Health	7
No. Advanced Dieback	2
No. Dead	0
Mistletoe	0
Flowers / fruit	8

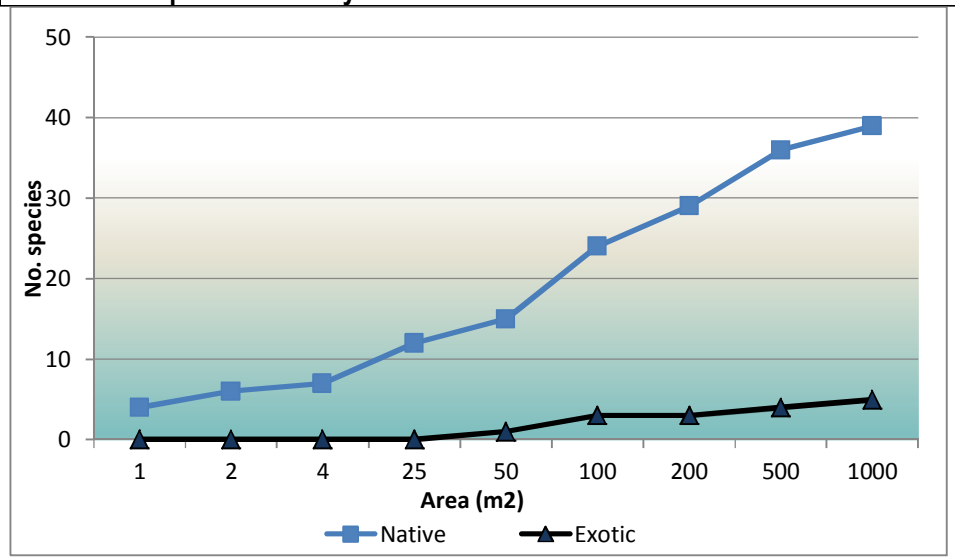
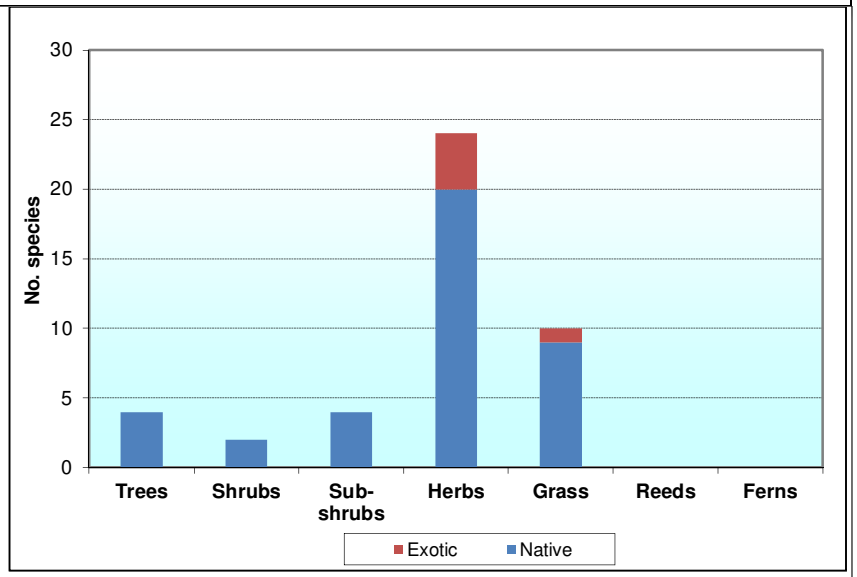
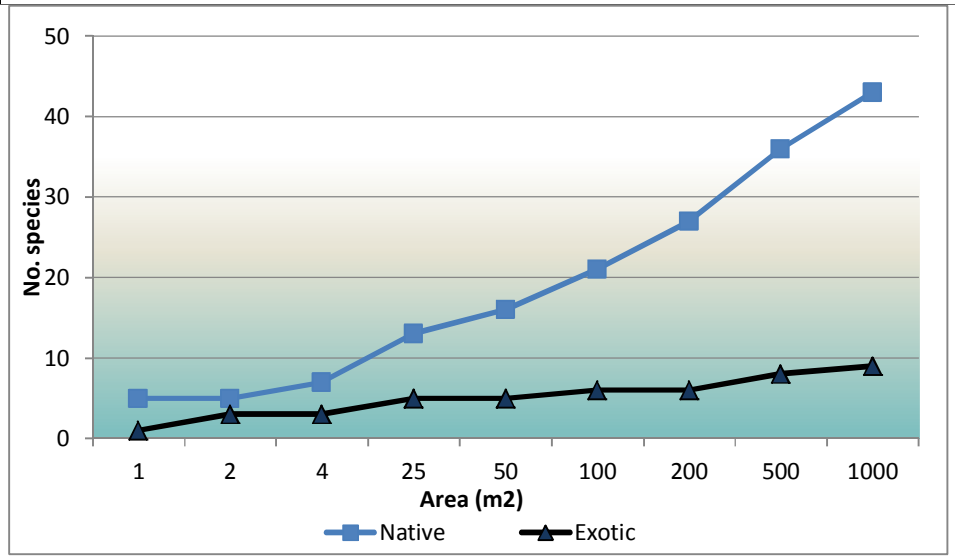
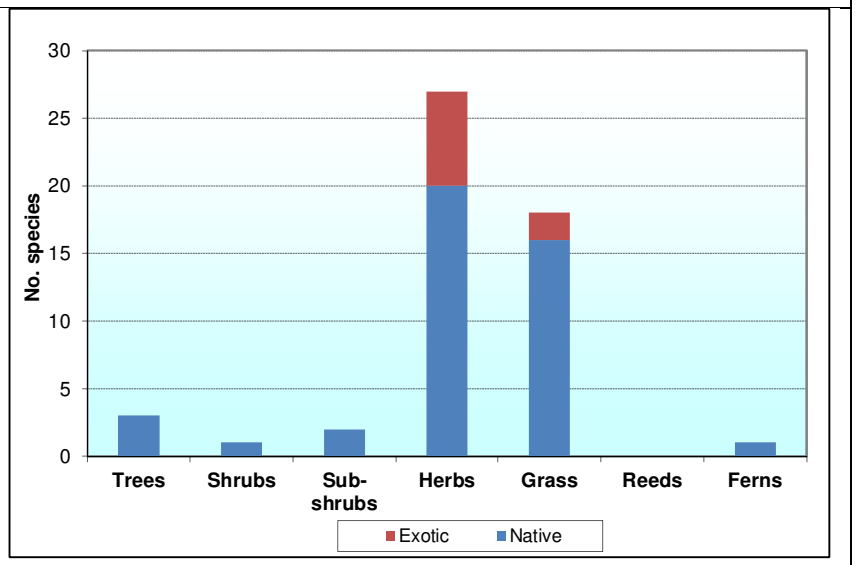


RWood04

Dominant species	*Eucalyptus populnea (2), Callitris glaucophylla (2), Eucalyptus melliodora (1)*
Average dbh (Cm)	54
Max dbh (cm)	82
Min dbh (cm)	35
Total trees	6
No. with multiple limbs	0
No. Live trees	5
No. Healthy	2
No. Medium Health	3
No. Advanced Dieback	0
No. Dead	1
Mistletoe	0
Flowers / fruit	5



Species diversity and community composition

Reference	Cumulative Species Diversity	Growth forms
RWood01		
RWood02		

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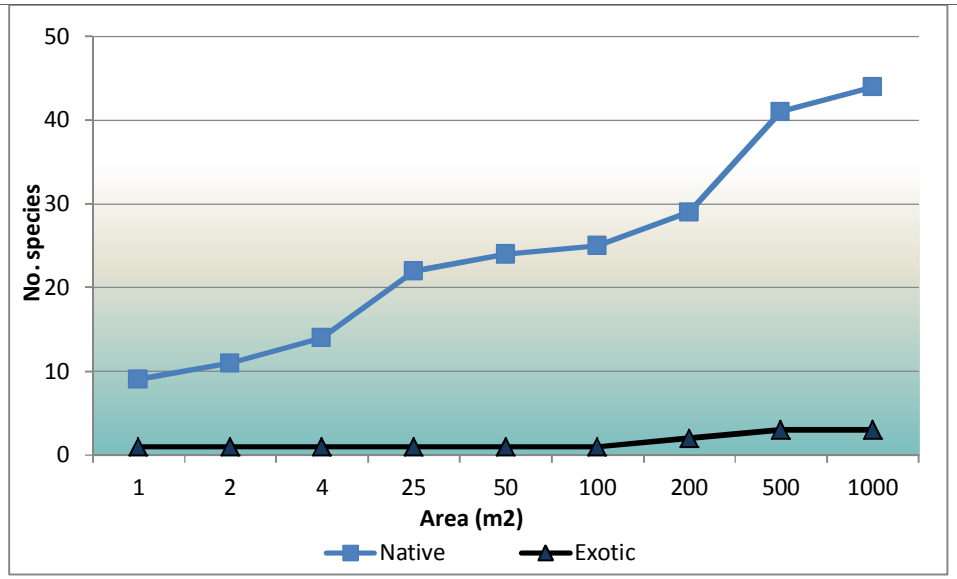

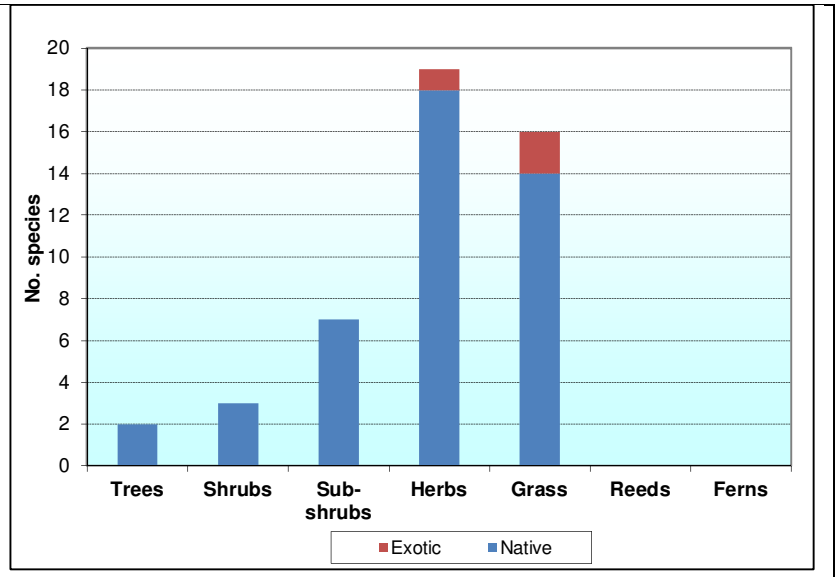

RWood04