Department of Environment and Science

Science supporting revision of codes for self-assessed vegetation thinning and fodder harvesting in Queensland

A summary for peer review

Queensland Government

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Introduction

The Queensland Herbarium (QH) provided scientific advice to the Department of Natural Resources and Mines and Energy (DNRME) to assist them in revising codes for clearing native vegetation between January 2016 and January 2018. DNRME's revision of the codes was guided by independent advice provided by Cardno in November 2015. The codes under review apply to self-assessable clearing under the Vegetation Management Act 1999 (VM Act) and had been prepared and came into effect in 2013 and 2014. They were still in effect in February 2018.

The purpose of the VM Act is to regulate the clearing of vegetation in a way that—

(a) conserves remnant vegetation that is—

(i) an endangered regional ecosystem; or

(ii) an of concern regional ecosystem; or

(iii) a least concern regional ecosystem; and

(b) conserves vegetation in declared areas; and

(c) ensures the clearing does not cause land degradation; and

(d) prevents the loss of biodiversity; and

(e) maintains ecological processes; and

(f) manages the environmental effects of the clearing to achieve the matters mentioned in paragraphs (a) to (e); and

(g) reduces greenhouse gas emissions; and

(h) allows for sustainable land use.

This document summarises advice from QH to DNRME in the course of their review and drafting of revised codes, which included QH involvement in stakeholder consultation. A letter from QH Director, Dr Gordon Guymer, to DNRME outlining our initial response and advice in February 2016 is attached as Appendix A. Advice from QH was conveyed to DNRME before and after this letter primarily in meetings or as tracked changes on drafts of updated codes between January 2016 and December 2017. This document deals only with advice regarding codes for managing thickened vegetation (thinning) and fodder harvesting, and includes brief reviews of the scientific literature and evidence base relied upon in formulating the advice.

QH is a scientific institution responsible for maintaining critical and foundational scientific information on Queensland's biodiversity (flora, fauna and ecosystems) utilised by the VM Act and other legislation. These include responsibility for the classification, description, survey and mapping of regional ecosystems (REs) across Queensland. REs and RE maps are integral to the operation of the VM Act. The Herbarium is part of the Science division within the Department of Environment and Science (DES). Other units within DES also provide scientific support for Vegetation Management policy and regulation, some advice from the broader DES science capacity is also outlined in this document, particularly advice related to remote sensing.

QH advice on codes for thinning (Managing thickened vegetation accepted development codes)

Thinning is defined in the dictionary schedule of the VM Act as follows.

"Thinning –

1. means the selective clearing of vegetation at a locality to restore a regional ecosystem to the floristic composition and range of densities typical of the regional ecosystem surrounding that locality.

2. The term does not include clearing using a chain or cable linked between 2 tractors, bulldozers or other traction vehicles.”

Currently there are five acceptable development codes for self-assessable thinning to manage thickened vegetation. Each deals with different clusters of Queensland bioregions. They came into effect in August 2014. The codes all require thinning to achieve specific outcomes. The outcomes vary slightly across the codes but are generally:

- regional ecosystems restored to the floristic composition and range of densities typical of the regional ecosystem
- ecological processes and biodiversity are maintained or restored
- landscape stability is maintained
- wetland and watercourse bank stability, water quality and habitat is maintained
- remnant vegetation and vegetation management class is maintained.

The Cardno review (2015) concluded that the 2013/14 thinning codes were likely to be consistent with most of the purposes of the VM Act. However, Cardno also suggested that some of the allowance for thinning in the codes raised potential for long-term negative effects on biodiversity and ecological processes, which would work against the purposes of the VM Act and the objectives of the codes.

The review identified a critical conceptual problem with the thinning codes in terms of the relative effects of clearing and thickening on biodiversity and ecological processes. Specifically, the thinning codes do not limit clearing to situations where thickening should be treated as a threatening process. This is because there is a well-supported view in the scientific literature that thickening is often an integral phase of the long term dynamics of natural vegetation. Dense cohorts of young trees and shrubs may be triggered by rare opportunities for successful regeneration and may be essential to maintaining viable tree and shrub populations in the highly variable Australian climate. Further, there is little direct evidence that thickening in the context of such dynamics represent a substantial threat to biodiversity. On the other hand there is a body of empirical evidence showing that clearing, even selective clearing, often has negative impacts on local biodiversity and increases the threat of weed invasion and other threatening processes. Moreover, the codes allow thinning in regional ecosystems that have been extensively cleared e.g. brigalow woodlands, which will likely exacerbate serious existing threats to regional biodiversity.

The review suggested that thinning is consistent with the purposes of the VM Act only where thickening threatens the ecological functioning and biodiversity of the RE at that locality. Cardno identified a need for consideration of whether there are threats from thickening for all of the regional ecosystems included under the code (**Thinning issue 1**). Other issues identified in the review are paraphrased here into the following five specific issues:

Thinning issue 2. The shrub layer (<2m tall) could be removed over large areas.

Thinning issue 3. The standardised mature tree size used in the code allow mature narrow-stemmed trees to be cleared. [The codes use diameter at breast height (dbh) to define ‘mature trees’ as those with a dbh greater than 30cm for eucalypts (*Eucalyptus, Corymbia, Lophostemon* and *Angophora*) and 20cm for others].

Thinning issue 4. The retention densities of immature trees and shrubs lack scientific basis [under the current 2013/14 codes mature trees and habitat trees are protected, immature trees >2m with dbh less than the thresholds above can be cleared down to densities specified by RE, and shrubs are defined for the codes as woody plants less than 2m tall].

Thinning issue 5. The codes allow clearing in some REs which have been significantly impacted by past clearing (such as brigalow communities) increasing potential for impacts on regional biodiversity.

Thinning issue 6. The codes permit thinning on the assumption that thickening has occurred, which may lead to clearing where there has been no thickening and is therefore no threat to biodiversity or function from thickening.

QH advice and recommendations in response to these six issues are summarised below. The summaries of advice and recommendations relating to each issue are followed by discussion of the scientific basis for QH responses where such detail was considered necessary. The summaries and discussion also make some mention of constraints considered by QH to ensure the application of the codes was practically achievable for landholders. Appendix B provides an overview of the main changes made from the current 2013/14 codes, to the draft code released for consultation in July 2016, and a draft developed to further reduce risk in December 2017.

QH advice on specific thinning issues

Thinning issue 1 – threat assessment

The first and over-arching issue identified by Cardno can be paraphrased as, “When does thickening pose sufficient threat to the ecological functioning and local biodiversity of a regional ecosystem to make thinning an appropriate response?”

Summary of advice regarding thinning issue 1

1. QH recommended REs to be removed from the code, and suggested restrictions on thinning activities permitted in others, on the basis of each REs current extent, the extent of past clearing, and susceptibility to negative impacts from thinning on biodiversity or ecosystem function, including increased risk of degrading processes such as buffel grass invasion in fire sensitive REs (particularly endangered REs, or REs associated with threatened ecological communities).
2. The code should only permit thinning in areas where substantial thickening has occurred.
3. The occurrence of thickening can be demonstrated by comparing historical and modern aerial photography. Quantitative photogrammetry can be used to assess changes in vegetation cover over time.
4. Satellite imagery can be used to assess trends in woody vegetation cover over shorter time periods (~30 years), and trends in cover can be assessed for correlation with rainfall variation to identify areas of thickening beyond explanation by climate variability.
5. In the absence of historical imagery a threshold density might be used to restrict thinning to areas with relatively high stem density for the regional ecosystem.

Summary of reasons and evidence for advice regarding thinning issue 1

1. Thickening is a common but patchy and complex process that can be identified by comparing historical vegetation descriptions or imagery with modern landscapes.
2. Causes of thickening can be complex, but there is a strong evidence base showing that decadal-scale variation in rainfall is a fundamental driver of woody plant density across the savannas and rangelands that cover most of Queensland. Extremely wet periods, which occur a few times per century, often cause widespread tree and shrub regeneration. Extreme droughts can cause severe mortality across broad regions and rapidly reduce the density and cover of woody plants, providing a counterpart to episodic recruitment of woody plants.
3. Changed fire regimes are clearly associated with many examples of thickening and is particularly important in regions where fire suppression coincides with the presence of rainforests or other fire sensitive trees such as cypress pine.
4. In arid and semi-arid rangelands potential for widespread fire is often limited by fuel connectivity and conditions conducive to fire are infrequent. This can reduce the potential importance of fire in affecting vegetation density and makes decade-scale variation in woody plant density related to rainfall even more important.
5. The impact of thickening on biodiversity is even more complex than the causes of thickening.
6. Dense vegetation typically reduces herbaceous cover and biomass, especially in the context of high grazing pressure. However it generally produces a marked increase in litter on the ground which can have nutrient cycling and water quality benefits (increased litter cover reduces rainfall impact, improves infiltration and decreases surface runoff).
7. Thinning of dense stands, reducing densities to levels more typical for the specific vegetation type involved, can increase herbaceous cover and biomass. However, there is little if any scientific support for the idea that increasing woody plant density generally, leads to degradation of ecosystem function or loss of biodiversity.
8. Thickening can be simultaneously detrimental to some species and beneficial to others.

9. Species negatively affected by thickening tend to be widespread in pastoral landscapes and are often also favoured by clearing, so they are generally not high priorities for biodiversity conservation.
10. Many species of conservation concern are associated with dense vegetation and do not benefit from clearing. There is a growing body of scientific evidence that thinning is unlikely to benefit avian biodiversity.
11. Thinning can increase risks of dominance by a few species, including weed invasion, and may increase the risk of an exotic-grass/fire degradation feedback in fire sensitive vegetation, such as the brigalow threatened ecological community.

Discussion of evidence regarding thinning issue 1

The extent of thickening in Queensland vegetation is variable across locations and regional ecosystems. Some ecosystems certainly have shown substantial increases in density or cover of woody vegetation over decadal or century time-scales (Burrows et al. 2002, Fensham and Fairfax 2005). However, at landscape scales there is also considerable evidence for a fair degree of consistency between uncleared modern vegetation and that described by early European explorers in terms of vegetation structure and dominant species (Fensham et al. 2005, Fensham 2008a, Fensham et al . 2011, Silcock et al. 2013).

The cause of increasing woodiness in Australian vegetation is commonly ascribed to modern management supressing fire and hence increasing survival and growth of trees and shrubs (Burrows 2002). For example, there is evidence of increasing density of rainforest plants under coastal eucalypt woodlands and forests (Russell-Smith et al. 2004). Rainforest expansion and irruption in savannas is well understood to be associated with fire management in coastal Queensland, from Cape York Peninsula (Russell-Smith et al. 2004) to south-eastern Queensland (Fensham and Fairfax 2005).

Thickening has also been widely reported from drier parts of Queensland. However, compared to rainforest boundary change, the cause of thickening in arid and semi-arid lands is not as clearly and directly related to management of fire and is also often discussed in association with overgrazing (Witt 2013). Overgrazing reduces fuel for fire, which can also exacerbate thickening by excluding fire even after wet seasons (Harrington 1979, Sharp and Whittaker 2003). Regardless of grazing, the primary problem in linking fire to thickening in arid and semi-arid rangelands is that fire is likely to have always been relatively rare in many systems, including those in south-western Queensland (Enright and Thomas 2008, Silcock et al. 2013). For example, evidence of vegetation thickening through the twentieth century is reasonably widespread in the Mulga Lands (Witt et al 2009, Witt 2013). However, the area burnt per year in that semi-arid region is strongly correlated with precedent rainfall. Significant areas are burnt only after extremely wet periods, a few times per century. This low frequency of fire, which was arguably also the case prior to the pastoral industry (Enright and Thomas 2008, Silcock et al. 2016), suggests that fire is too infrequent to impose tight controls on vegetation structure (Silcock et al. 2017). The influence of grazing on thickening in the mulga lands and elsewhere is scientifically interesting but is complex, interactive with other drivers and therefore difficult to generalise. A 65 year record of sheep diets in the northern mulga lands, did not support the prevailing perception of substantial increases in woody vegetation cover and declining grass cover (Witt et al. 2006). The amount of grass in the sheep’s diets certainly varied significantly over decadal scales, but the pattern of grass availability was not one of steady decline but was related to rainfall variation.

Even where fire is common in arid to sub-humid climates, there are serious questions about its influence on tree density at the stand scale, beyond impacts on specific species, and there is increasing emphasis in the scientific literature on the importance of climate in determining vegetation structure and demography (Murphy et al. 2015, Fensham et al. 2017b). Increasing density of woody vegetation is observed globally, primarily as increasing vegetation greenness measured using satellites (Liu et al 2015). Some of this global trend is expected to be related to increasing carbon dioxide in the air, which improves plant water use efficiency (Zhu et al. 2016). A small increase in water use efficiency might drive changes to vegetation structure because in dry climates water availability is fundamental to vegetation density for a given soil type and the importance of soil types to vegetation structure (Noy-Meir 1973, Fensham et al. 2015a).

The importance of water availability is also clearly apparent in the relationship between decadal climate variation and trends in woodiness and carbon flux (Bastos et al. 2013, Cleverly et al. 2016). Higher rainfall is strongly correlated with periods of increasing woody cover in western and central Queensland (Fensham and Fairfax 2005, Fensham et al. 2005). Similarly, drought can cause substantial declines in woody cover over large areas (Fensham et al. 2009). Decade and century scale climate, particularly rainfall variation, is the principle environmental component driving tree density variation in savannas of Queensland and Australia (Strickland et al. 2016). This long term variability in woody density demonstrates the importance of extremely wet periods to regeneration opportunities for trees in Australian rangelands, which may occur a few times per century, and the potential for thinning to affect long term population viability (Maher 1995, George et al. 2005).

Assessing the threat of thickening to biodiversity involves all of the issues around extent and cause introduced above plus details of resultant changes to the functions and biodiversity of affected regional ecosystems.

Thick vegetation typically reduces pasture biomass and cover (Burrows 2002, Jones et al. 2015, Fensham et al. 2012, but see Thompson and Eldridge 2005) and can also influence soil condition (Tighe et al. 2011). This reduction in the herbaceous layer is presumably why thickening is so often described as a threat to biodiversity (Page et al. 2000, Witt 2013). However, detailed studies of ecosystem response to woody plant increases provide little support for the idea that increasing woody plant density generally and necessarily leads to degradation of ecosystem function or loss of biodiversity (Eldridge and Soliveres 2014, Good et al. 2011). There is certainly good evidence for an impact of thickening on herbaceous biomass and cover, especially in the context of grazing, and this is presumably the primary reason for interest in thinning among graziers. Reduced herbaceous biomass may also make appropriate grazing management more difficult to achieve, which may in turn increase the risk of degradation from overgrazing. However, it should be noted that the quality of pasture beneath trees is often higher in terms of nutrient content and digestibility (Silcock et al. 1985, Jackson and Ash 1998, 2001). Also, trees and shrubs together with the debris and litter they drop and the herbaceous layer that can be sustained beneath them can provide sufficient total plant cover to intercept and hold rainfall and nutrients and provide a functional system (Ludwig and Tongway 1995). Trees and shrubs are particularly important to holding soil and nutrients in arid systems exposed to wind erosion, such as south-western Queensland (Webb et al. 2005). Thinning of stands with densities far higher than typical for their vegetation type, to reduce density to around benchmark levels more typical for their vegetation type, can be used to increase ground cover and will often also increase herb diversity (Jones et al 2015, Dwyer et al. 2018).

There are some well documented negative impacts on biodiversity from thickening. For example, there are clear landscape-scale biodiversity threats from the rapid decline in grassland and grassy forest extent in the Bunya Mountains National Park in southeast Queensland (Butler et al. 2014). The grasslands are being replaced by forests, and the change is accelerated because of low fire frequency (Fairfax et al. 2009). Conversion of grassland or grassy forest to rainforest causes substantial change to local biodiversity, particularly for plants (Butler et al. 2006). However, the resultant new forests are nonetheless rich and functioning examples of native ecosystems. Fire can slow the expansion of rainforests into grassy systems, but it doesn't appear capable of halting conversion of grassland to grassy forests, which is also progressing at pace in the Bunya's (Fensham and Fairfax 2006). However, the conversion of grassland to grassy forest has been shown to have minimal impacts upon local plant diversity or animal diversity (Butler et al. 2006, Smith et al. 2015).

The plight of the endangered golden-shouldered parrot on southern Cape York Peninsula is probably the highest profile example of biodiversity threat involving woody thickening. The parrot feeds on grass seeds and it excavates nests in termite mounds. Its habitat has seen increasing density of ti-tree, which is associated with a changed fire regime and is believed to increase the risk of predation of parrots near their nests during the wet season. The Commonwealth's Threatened Species Scientific Committee released a conservation advice in July 2017 which identifies grazing and pigs as known threats and thickening through changed fire regimes as a 'suspected threat' (TSSC 2017).

However, compelling examples of potentially significant impacts of increased vegetation densities on biodiversity or function, such as the case of the golden-shouldered parrot, appear to be exceptions rather than the rule. Generally, changes to vegetation structural change might be expected to benefit some species and disadvantage others, the outcomes depend upon the detailed ecology of the species involved (Eldridge et al. 2011). Thinning of dense stands can increase pasture cover but what other effects does such clearing have?

Research in inland Queensland suggests that components of biodiversity that are favoured by clearing, those that benefit from open habitats, are also likely to be favoured by thinning. Species that benefit from clearing tend not to be at risk of extinction. For example, Tassiker et al. (2007) compared bird species assemblages in central Queensland across a range of density classes including thinned and cleared areas and found that thickening can benefit some species. They concluded that thinning tended to benefit common and widespread species but generally had a negative overall effect on bird species richness. A similar study assessed the relationships between an index of grazing land condition and vertebrate biodiversity in northern Queensland and found very poor correlation between the two. Grazing condition and biodiversity were not aligned because woody thickening reduces grazing land condition but generally promoted vertebrate diversity in the study area (Parsons et al. 2017).

Clearing of native vegetation is a known direct threat to biodiversity, but can also exacerbate the impact of other threatening processes, such as susceptibility to predation (Neldner et al. 2017a). Predation by feral animals, and in particular cats, is becoming increasingly linked with not only clearing rates, but simplification of vegetation structure through fire or thinning. Cats are less common in areas with dense understories, and the maintenance of shrub densities has been linked to the conservation of many threatened ground-dwelling mammal and bird species (Davies et al. 2016; Woinarski et al. 2017). The impact of not only broadscale but selective vegetation clearance on biodiversity may take decades to become apparent (McAlpine et al., 2002), with multiple interacting stressors accumulating over time and space (Halpern and Fujita 2013). Extinction debt works through local extinctions gradually becoming regional: eventually, the entire species is made extinct. In addition, immigration lag, in which small or isolated patches are slower to accumulate species, has been shown to result in 5 per cent fewer species after one year, and 15 per cent fewer species after 10 years (Haddad et al., 2015).

In Queensland's rangelands there are two local ecological stories that are particularly relevant to potential negative impacts on biodiversity from thinning. Specifically, miner birds, and fire sensitive Acacia woodlands that are prone to buffel grass invasion.

Noisy miners, and the similar yellow-throated miners, are aggressive and territorial birds that have been labelled as 'avian despots' in eastern Australian savannas (MacNally et al. 2012, 2014). They are implicated in the ongoing decline in the distribution and abundance of small woodland birds across southern and eastern Australia. The miners prefer parklike vegetation with open understoreys and woodland edges (Piper and Catterall 2003, Clarke and Oldland 2007, Eyre et al. 2009a, Kutt et al. 2016) which means that they are likely to be favoured by thinning and clearing, as has been shown in thinning of cypress (*Callitris glaucophylla*) dominant forest (Eyre et al. 2015). Unlike miners, most woodland bird species show positive responses to increasing vegetation density (Kutt and Martin 2010), and many smaller woodland birds are threatened by the aggressive behaviour of miners (MacNally et al. 2014). The dominance of noisy miners and yellow throated miners in fragmented and simplified vegetation is one reason to expect many negative outcomes from thinning for avian biodiversity.

Buffel grass is one of many exotic pasture grasses widely naturalised globally in semi-arid and arid environments, including many of Australia's rangelands. It is a declared plant under the Natural Resources Management Act in South Australia. It typically causes substantial negative impacts on biodiversity (Smyth et al. 2009, Marshall et al. 2012), but is particularly problematic because it, like other bulky invasive grasses, can alter fire behaviour in ways that transforms some ecosystems (Butler and Fairfax 2003, Clarke et al. 2005). Buffel grass invasion and the resultant grass/fire cycle can drastically alter woodlands dominated by fire sensitive Acacia's such as brigalow. Brigalow ecosystems have been extensively cleared so increasing threats to remaining patches is a biodiversity issue. Most brigalow regional ecosystems are listed as endangered in the VM Act and as an endangered ecological community under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*.

In Queensland, at the landscape scale, propagule pressure is a key driver of buffel grass invasiveness (Clark et al. 2005, Eyre et al. 2009b, Butler et al. 2014, Fensham et al. 2015b). It has been shown that in Queensland's semi-arid and savanna landscapes, clearing and habitat fragmentation exacerbates the spread of buffel grass into retained remnant patches, particularly in landscapes with < 30% of remnant vegetation (Eyre et al. 2009b, Fensham et al. 2015b). At the patch scale, dense tree and shrub cover can help to supress buffel biomass (Butler and Fairfax 2003, Butler et al. 2014), so that thinning of brigalow, gidgee or other fire sensitive ecosystems that are prone to degradation through buffel invasion is clearly not appropriate for conservation of biodiversity (Melzer 2015). Similar patterns of buffel grass invasion and resultant loss in flora and fauna species diversity have also been observed in the less fire sensitive and more open eucalypt dominant woodlands throughout Queensland (Hannah et al. 2007, Eyre et al. 2009b), where even relatively small amounts of canopy removal further intensifies the spread of buffel grass (Franks 2002, Eyre et al. 2009b).

Finally, we must acknowledge that there is currently considerable uncertainty regarding the short and – in particular – long-term ecological impacts of selective stem removal during restoration thinning (Dwyer et al. 2009). The limited studies on the effect of thinning on structural attributes important for biodiversity in Australian landscapes suggest mixed responses but also some perverse outcomes (Waters et al. 2018). For example, short-term outcome of thinning is often increased levels of coarse woody debris (CWD). Coarse woody debris is important habitat for many species, but is dependent on CWD age or decay status and size, where older and larger CWD provide increased habitat value (MacNally et al. 2001). The smaller sized, younger stems left as CWD following thinning activities have less habitat utility, but also eventually lead to changed burning regimes, which also has implications for biodiversity (Eyre et al. 2015; Waters et al. 2018).

Discussion of recommended solutions

Our recommended solutions to address issue 1 were to restrict thinning to situations where substantial thickening is likely to have occurred (discussed under Issue 6), and to remove regional ecosystems from the code where thinning was considered not to be a low risk activity.

The REs covered by the thinning codes were reviewed initially in January 2016 by the Herbarium officers responsible for coordinating survey and mapping of regional ecosystems in each bioregion, then by the Science Leader for the Vegetation Survey and Mapping team at QH. Our initial recommendations were presented to DNRME in a table with justification for why self-assessable clearing in each RE should be seen as high risk, and we entered into discussions about specific REs and risks with DNRME to arrive at the list in the revised code that was put out for public consultation in July 2016. The most common reasons we recommended removal in this initial stage was for; endangered status, REs that form part of a nationally listed threatened ecological community, REs with very limited remnant extent (<1000 ha) REs on landforms subject to high risk of erosion, riparian REs in arid bioregions that may be subject to very rare recruitment opportunities and wetland REs. Negotiation with DNRME and stakeholder feedback meant that not all of the recommended changes to the REs were adopted for the draft code released for consultation in 2016. Despite this variance between QH recommendations and outcomes, QH endorsed the draft code from July 2016 as a substantial improvement on the 2014 code, which would greatly reduce the risk of negative outcomes for biodiversity and ecosystem function.

In December 2017 QH was asked to identify potential further changes to the 2016 draft thinning code to further reduce the risk of poor outcomes for biodiversity. To this end we undertook a new review of the REs in the draft code with a lower level of acceptable risk. For the 2016 draft, which focussed on avoiding high risk activities, we recommended removing REs based primarily on endangered status (State or Commonwealth), or remnant extent less than 1000 ha, riparian or wetland values, or highly erodible landforms. When asked to further reduce risk in December 2017 QH recommend removing all of those identified for the 2016 review (not just those settled following negotiation) as well as REs with ‘Of Concern’ status and remnant extent less than 5000 ha, as well as Of Concern wetland REs. These are also listed in Appendix C. These changes reduced the number of REs included in the codes from 489 in the current 2013/14 code to 413 in 2016 and 332 in 2017, which changed the area of remnant vegetation potentially covered by the code from approximately 65.3 M ha in 2013/14 to 61.1 M ha in 2016 and 55.7 M ha in the draft from December 2017 (Appendix B).

Thinning issue 2 – retaining low shrubs

Issue 2 was “The shrub layer (<2m tall) could be removed over large areas”

Summary of advice and solutions regarding thinning issue 2

1. Limit the area that can be thinned under a single notification
2. Require retention of 10% cover of target species after thinning low shrubs
3. Apply 5 m tree protection zones for chemical techniques as well as machines

4. Improve protection of immature trees (i.e. > 2m height but smaller dbh than a mature tree, the current code only protects mature and habitat trees).

Summary of reasons and evidence regarding thinning issue 2

The 2014 code requires that thinning of low shrubs (<2m tall) can only occur where those plants cover more than 50% of the ground surface. It also requires that no mechanical thinning of low shrubs occur within 5m of a mature or habitat tree. These buffers are tree protection zones but will also provide ecologically valuable refuges throughout the community and should be extended to chemical thinning techniques. Requiring retention of 10% cover of the target species will also ensure that low shrubs are not completely removed. Requiring retention of immature trees, rather than just mature and habitat trees as in the current 2013/14 codes, will reduce risk of significant impacts on other parts of the RE structure from thinning targeting low shrubs (e.g. where immature tree density is insufficient to permit thinning of immature trees, or the RE is included in the code only for thinning of low shrubs).

Thinning issue 3 – narrow-stemmed mature trees

Issue 3 with the thinning code was "The standardised mature tree size used in the code allows mature narrow-stemmed trees to be cleared in some REs". Put another way, there are tree and shrub species that are 'mature' at sizes below the threshold set for mature trees in the code.

Summary of advice regarding thinning issue 3

1. Increase the retention rates for immature trees to those recommended in Fensham (2008b, see Issue 4)
2. Introduce the concept of 'tall immature trees' to ensure that the largest twenty trees in a system are retained and also protected by a 5m buffer

Summary of reasons and evidence regarding thinning issue 3

QH agreed that the mature tree dbh thresholds may not be low enough to identify all old trees in some REs, nor will they protect all old individuals of smaller tree and shrub species. They are an arbitrary threshold, but are simple and easy to measure. No conceivable approach to identify all significant individuals in an RE would be practical for self-assessment.

QH recommended against establishing different thresholds for different regions provided that the suggested densities for immature tree retention are adopted (Issue 4). This is because we judge that the likely benefit of having different thresholds for different regions would not be sufficient to justify the additional complexity. Increasing the retention rate will make a far greater difference to the level of risk to biodiversity and ecosystem function in most circumstances.

The concept of tall immature trees is recommended to reduce risk of excessive impacts on ecosystems with low numbers of mature trees. It is also simple to apply.

Thinning issue 4 – scientific basis for retention densities

Issue 4 was that "The retention densities of immature trees and shrubs lack scientific basis"

Summary of advice regarding thinning issue 4

QH recommended adopting retention densities based on published data and recommendations from Fensham (2008b)

Summary of reasons and evidence regarding thinning issue 4

Fensham (2008b) assembled population density data for stems >2m tall in very-sparse, sparse and mid-dense REs. They came from four data sets described by peer reviewed publications that collectively sampled the Brigalow Belt, Desert Uplands, Mitchell Grass Downs, and South-east Queensland bioregions. The same paper recommended retention rates for immature trees based on those data (Figure 1). We recommend using those retention rates (also see Issue 6).

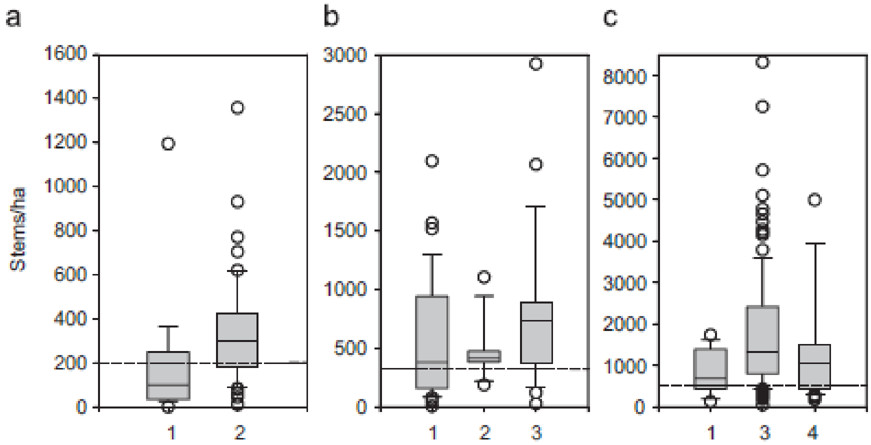

Fig. 1. Box plots of immature tree stem densities for different data-sets (key to data-sets in Table 2) for the three structural categories: (a) Very sparse, (b) Sparse, (c) Mid-dense. The median is identified within the box, limits of the box identify the 25th and 75th percentile, error bars identify the 10th and 90th percentiles, and circles are outliers. The thresholds identified by the procedure described here are represented by the dashed lines. Note immature stem densities are overestimated by Data-set 3 and underestimated by Data-set 4 because of variations in methods (Table 2).

Figure 1 Scanned copy of Figure 1 from Fensham 2008b. The plots show distributions of immature tree density for very-sparse (a), sparse (b) and mid-dense (c) REs. The horizontal lines across the figures shows the retention requirements for immature trees after thinning.

Thinning issue 5 – impacts on regional biodiversity from clearing fragmented REs

The 2013/14 codes allow clearing in some REs that have been significantly impacted by past clearing (such as brigalow communities) increasing potential for impacts on regional biodiversity.

Summary of advice regarding thinning issue 5

1. QH recommended restricting thinning to REs in which the negative impacts of thinning are unlikely to substantially increase known risks to biodiversity (e.g. endangered or restricted REs), or to increase known risks of land degradation (e.g. tall shrublands on extremely sodic and dispersive soils)
2. Limit the area that can be thinned under a single notification

Summary of reasons and evidence regarding thinning issue 5

Neldner et al. (2017a) reviewed the literature on clearing impacts and biodiversity in the Queensland context. These include regional-scale accumulation of pressure on populations of native biota as they are fragmented and confronted by invasive species as well as native increasers such as noisy and yellow-throated miners. The impact of habitat modification, such as through thinning, grazing and/or fire, is cumulative, particularly in fragmented landscapes where biodiversity is already under stress. See the discussion of evidence for Issue 1 for a brief description of some of the evidence that leads us to expect that thinning will further increase cumulative pressures on biota within fragmented REs.

For the 2016 draft, which focussed on avoiding high risk activities, we recommended removing REs based primarily on endangered status (State or Commonwealth), or remnant extent less than 1000 ha, riparian or wetland values, or highly erodible landforms, as described under Issue 1. When asked to further reduce risk in December 2017 QH recommend removing all of those identified for the 2016 review (not just those agreed after negotiation) as well as REs with ‘Of Concern’ status and remnant extent less than 5000 ha, as well as Of Concern wetland REs.

Thinning issue 6 – demonstrating thickening has occurred

The codes permit thinning on the assumption that thickening has occurred, which may lead to clearing where there has been no thickening and is therefore no threat to biodiversity or ecosystem function from thickening.

Summary of advice regarding thinning issue 6

1. The code should only permit thinning in areas where substantial thickening has occurred.

2. The occurrence of thickening can be demonstrated by comparing historical and modern aerial photography. Quantitative photogrammetry can be used to assess changes in vegetation cover over time.
3. Satellite imagery can be used to assess trends in woody vegetation cover over shorter time periods (~30 years), and trends in cover can be assessed for correlation with rainfall variation to identify areas of thickening beyond explanation by climate variability.
4. In the absence of historical imagery a threshold density might be used to restrict thinning to areas with relatively high stem density for the regional ecosystem.
5. If a threshold density is used then transects established by landholders to establish that threshold density has been exceeded should be retained, not cleared.
6. When notifying DNRME of their intent to use the code, landholders should define the area to be thinned and provide that information with the notification.

Summary of reasons and evidence regarding thinning issue 6

Several potential ways to identify areas where substantial thickening had occurred were recommended. Initially we suggested a comparison of aerial photographic imagery (historic and recent) be made, and density of count of trees from both sets of imagery to provide evidence of tree thickening. A method along these lines was developed by the QH and we have confidence in its utility (Fensham and Fairfax 2007, Fensham 2008b). This method was utilised for assessment of applications to thin prior to the self-assessable code (under the Regional Vegetation Management Codes RVMC), but this suggestion was rejected after discussions with DNRME and stakeholders, as it was considered impractical for landholders to implement.

A second recommended method to identify areas that had thickened substantially was to use data on trends in persistent green fractional cover from the Landsat archive (Scarth *et al.* 2010, Flood *et al.* 2013). These data are readily available from the Science Division's Remote Sensing Centre in DES. DNRME asked regional officers to assess the potential for these products to be used to identify thickening. However, the decision was made not to use satellite data to constrain clearing to areas where thickening was clearly occurring.

The final approach recommended, and adopted in the latest drafts, was to set thresholds for stem density that are considered to be well above the average for the structure of the relevant RE. This approach is similar to that used by Jones et al. (2015) to identify where thinning of regenerating stands might be used to bring the density of stems back to levels closer to those expected for the relevant vegetation type.

Queensland's REs are all assigned to structure categories based on canopy cover (Neldner et al. 2017b). We recommended using these categories to set thresholds for immature tree density (plants >2m tall but below the dbh thresholds for mature trees), so that thinning could only occur if the vegetation contains a greater number of immature trees per hectare than the threshold identified for its structure class. The 2014 thinning codes require landholders to measure the density of their vegetation prior to thinning, so this approach introduces little additional complexity. The structure category for REs is already published on the RE Description Database (REDD). QH applies 4 categories: dense >80% crown cover; mid-dense 50-80% crown cover; sparse 10-30% crown cover, and; very sparse <10% crown cover. Dense REs are already excluded from the thinning codes. Fensham (2008b) compiled data on the density of immature trees across central and southern Queensland for the other three structure categories (mid-dense to very sparse), which we used to recommend the thresholds in Table 1. The densities for retention in Table 1 follow Fensham (2008b). QH also reviewed the structure classification of each RE to ensure that they were correctly coded.

Table 1 Recommended thresholds for density of immature trees per hectare to be exceeded before thinning and retained after thinning, by RE structure categories.

Regional ecosystem structural category	Immature tree stem number per hectare to be exceeded before thinning	Minimum immature tree stem number per hectare to be retained after thinning
Very sparse	500 immature trees	200
Sparse	750 immature trees	300
Mid-dense	1250 immature trees	500

Requiring retention of the vegetation within the transects used to assess pre-thinning density will help reduce risk of poor outcomes for biodiversity by retaining small refuges within the thinned area. It will also improve the evidence base for audits and compliance.

Improving the spatial data submitted with notifications will enable checking of REs and trends in woody cover apparent in remote sensing. Data could be captured using a portable GPS device or simply drawing the boundaries on a map either digitally or simply on a paper property map to be digitised at the local government agency and converted into a spatial coverage. This will greatly improve the efficiencies of analysing the purposes for vegetation clearing, and improve the efficiencies of the rapid compliance assessment.

QH advice on fodder code (Managing Fodder Harvesting accepted development code)

Fodder harvesting is a well-established practice in south-western Queensland, going back more than a century, and is integral to the economics of pastoralism in that region (Beeton et al. 2005, Page et al. 2008). The predominant fodder species is mulga (*Acacia aneura*) but other species are also covered by the code. Specifically, umbrella or bastard mulga *(Acacia brachystachya* formerly *Acacia cibaria),* ironwood *(Acacia excelsa),* myall *(Acacia pendula),* bastard mulga *(Acacia sibirica* and *Acacia clivicola,* formerly *A. stowardii),* red ash *(Alphitonia excelsa),* leopardwood *(Flindersia maculosa)* and wilga *(Geijera parviflora).*

The current code for self-assessable fodder harvesting ("Managing fodder harvesting accepted development code") was introduced in December 2013. The purpose of the fodder harvesting code is to regulate clearing of remnant vegetation (Category B area) for fodder harvesting to achieve the following environmental outcomes (section 1.3 of the code):

- Sustainable management of the fodder resource.
- Provision of necessary fodder for stock only.
- Conservation of regional ecosystems within areas harvested for fodder.
- Prevention of land degradation.
- Maintenance of the remnant status of the vegetation
- Maintenance of bank stability, water quality and habitat of wetland, watercourse and drainage features.
- Conservation of essential habitat.

Fresh mulga leaves have reasonable feed quality and can keep stock alive. Even without harvesting, mulga browse during the dry season has allowed more stock to be carried in the Mulga Lands bioregion than would be expected from the low and erratic rainfall and infertile soils. A mature sheep will eat 700-1400 grams of mulga leaf each day under dry paddock conditions (Beeton et al. 2005), but this provides barely enough energy to maintain it (FutureBeef 2018). Fodder harvesting is one part of a sound drought strategy, which should also involve reductions in animal numbers early in a drought to ensure that landholders are not carrying too many stock (FutureBeef 2018). Fodder harvesting is not contingent upon drought declaration in the current or revised codes discussed here. It can be carried out at any time.

In the early days of pastoralism in western Queensland fodder harvesting was a labour intensive practice involving lopping off some of the limbs of the fodder tree to feed the existing stock and maintain a sustainable resource. Individual mulga plants have been estimated to live for around 250 years at Koonamore Station in South Australia (Crisp 1978), and hence this low level of utilisation was a sustainable practice that maintained the resource.

In the latter part of the 20th century, more mechanised clearing, including the use of chains or cables drawn between two machines, led to extensive areas being cleared of fodder trees, principally mulga *Acacia aneura*. Use of machinery for fodder harvesting is far cheaper than lopping (Page et al. 2008). However, there is a perceived risk that allowances for fodder harvesting may be used for transformative clearing, to convert woodlands and shrublands to grasslands, or to change the structure of mulga vegetation to keep the foliage within reach of stock (so called mulga farming) (Beeton et al. 2005). Vegetation clearance in the Mulga Lands Bioregion gradually intensified through the second half of the twentieth century after a policy of closer settlement was introduced (Page and Beutel 1995). Mulga dominated open forest, woodlands and shrublands were relatively extensive across the bioregion, but have since experienced extensive land clearing and rapid contraction in the higher rainfall part of the bioregion, mainly east of the Warrego River (Wilson 1999). The Mulga Lands bioregion has consistently had some of the highest rates of remnant and woody vegetation clearing since comprehensive clearing data has been analysed by Queensland's Statewide Land and Tree Clearing Study (Queensland Department of Science, Information Technology and Innovation 2017, Accad et al. 2017).

The current fodder code identifies different types of fodder harvesting and limits their application as follows:

1. Lopping of fodder species, where the removal of tree branches does not result in the death of the tree, is not regulated by the Vegetation Management Act and may be undertaken without approval under the vegetation management framework at any time
2. Selective harvest, where a saw or machine is used to fall selected individual trees. The current 2013 code limits this practice to take no more than half of the fodder species in an area, precludes repeat harvest within 10 years, limits removal of non-fodder species to that required for access, and applies buffers to minimise risks of land degradation
3. Strip and block harvesting practices are limited to REs where fodder species form the predominant canopy. They allow harvesting using a single machine, or two machines with a chain, to fell strips or blocks in areas that have not been harvested within the preceding 10 years. Strips up to 135m wide must be accompanied by strips of retained vegetation 165 m wide and the retained strips cannot be harvested for 10 years after the strip was felled. Similarly, blocks can be up to 4 ha and must be separated by 100m of retained vegetation, which cannot be harvested for 10 years. Non-fodder species more than 4m tall must be retained, REs less than 10ha or 500m wide cannot be felled as strips or blocks, and buffers around specified landforms such as scarps, watercourses and wetlands are used to avoid causing land degradation

The Cardno review (2015) considered that clearing permitted under the fodder harvesting SAC in its current form is not consistent with all purposes of the VM Act or the objectives of the code. Issues Cardno flagged are as follows.

Fodder issue 1. The current code allows re-harvesting of areas after 10 years, but many western REs require more than 10 years to grow back to remnant status

Fodder issue 2. Repeated strip and block harvesting can potentially cause large areas of existing remnant REs to become mappable as non-remnant

Fodder issue 3. A remnant RE can be cleared to the extent that it becomes mappable as non-remnant

Fodder issue 4. The current codes have increased the number of REs that can be fodder harvested from 32 to 53 compared to previous regional vegetation management codes (RVMC)

Fodder issue 5. The current codes allow selective harvesting of Endangered and Of Concern REs, which were not covered under the RVMC for fodder

Fodder issue 6. The current codes allow harvesting and machinery closer to watercourses and wetlands than has previously been allowed for fodder harvesting under the RVMC

QH advice and recommendations in response to these six issues are summarised below. The summaries of advice and recommendations relating to each issue are followed by discussion of the scientific basis for QH responses where such detail was considered necessary. The summaries and discussion also make some mention of constraints considered by QH to ensure the application of the codes was practically achievable for landholders. Appendix D provides an overview of the main changes made from the current 2013 codes, to the draft code released for consultation in July 2016, and a draft developed to further reduce risk in December 2017.

QH advice on specific fodder issues

Fodder issue 1 - REs require more than 10 years to grow back

The Cardno review (2015) raised concern that “REs in the Mulga Lands, Channel Country and Mitchell Grass Downs bioregions may fail to reach remnant status within a 10 year period following clearing (based on published annual growth rates)”. The code permits re-harvest of fodder areas after 10 years, including harvest of the retention areas associated with strip or block harvest, but if the harvested areas have not significantly recovered then such re-harvest is unlikely to be consistent with the following code objectives:

- Sustainable management of the fodder resource.
- Conservation of regional ecosystems within areas harvested for fodder.
- Maintenance of the remnant status of the vegetation

Summary of advice regarding fodder issue 1

1. QH agrees that that the current code risks enabling unsustainable practices that could remove remnant vegetation by allowing re-harvest of fodder areas after 10 years, before it has recovered its structure. This risk is particularly relevant if fodder harvesting cut strips or blocks within areas that were retained vegetation for previous strip and block harvest areas before the previously harvested areas had recovered.
2. QH recommended that strip and block harvesting cannot occur in an area previously harvested until after 10 years and until there is evidence of substantial recovery of the harvested area such that fodder trees are at least 4 m tall and are at least 70% of the height of fodder species in retained areas.

Summary of reasons and evidence regarding fodder issue 1

Sustainable management of the fodder resource and maintenance of remnant regional ecosystems would require adequate time for recovery of structure, floristics and biomass prior to re-harvest. To meet remnant status the tree canopy must reach at least 70% of the vegetation’s undisturbed height. This canopy height varies with the regional ecosystem decreasing in height from the eastern part of the Mulga Lands (where it is typically around 10m but can range up to 20m, BioCondition benchmarks for 6.7.1 and 6.7.11), to the west (where it is typically around 4 m but can be as low as 2 m, e.g. benchmarks for 6.7.9, 6.7.10 and 6.7.16) (Queensland Herbarium Mulga Lands benchmarks http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks).

The growth rates of trees in semi-arid Queensland are dependent on the availability of soil moisture and are also sensitive to grazing. Appendix E provides photographs illustrating mulga recovery after fodder harvesting. Reported height-growth rates of mulga in Queensland range from 22 cm yr^{-1} (ungrazed, average for wet and dry periods, (Brown 1985); ~30 cm yr^{-1} (Beale 2004, cited in Beeton et al. 2005); to 30-41 cm yr^{-1} (ungrazed, wet periods; Brown 1985). Hence over 10 years mulga can only be expected to grow to a maximum of four metres in the best of conditions.

Stock can reach mulga leaf up to 2 meters high (Future Beef 2017), sometimes by breaking the shoots. This means that grazing pressure can maintain regrowing mulga in a suppressed state. Brown (1985) studied regrowing mulga under varying sheep grazing intensity and concluded that “*Even the lightest* *grazing arrested mulga growth and prevented the transition from low mulga to the taller forms used for drought feeding. This is discussed as a possible cause of reported declines in drought reserves of mulga. The results of this study illustrate the need to ensure that grazing strategy is compatible with uninterrupted replacement of umbrella mulga (5-8 m high) cut for drought fodder.*"

This sensitivity of mulga's growth rate to grazing management implies that a simple time threshold cannot ensure that fodder harvesting maintains remnant vegetation. Particularly if the time threshold is 10 years, which is enough time for mulga to reach about 4 m, but only under ideal conditions. Criteria regarding outcomes are required, but they also need to reflect variation in potential height across the REs covered by the code. Therefore, QH recommended an additional requirement that strip and block harvest cannot occur in a previously harvested area (including in retained areas associated with a previous harvest) until the previously harvested areas have recovered so that fodder species within them have an average height at least 70% of the height of fodder species in the previously retained area. Similarly, an area should not be eligible to be a retained area for strip or block harvest unless the fodder species in it are more than 70% of the height of fodder species in the area to be harvested.

Fodder issues 2 and 3. Maintaining mapped remnant extent

Cardno (2015) raised several issues regarding maintenance of remnant vegetation, which also overlap with issue 1 addressed above. They identified these as separate issues, which we've numbered as issues 2 and 3, but they will be treated together here because they both relate to mapped extent of remnant vegetation. Issue 2 was "repeated strip and block harvesting can potentially cause large areas of existing remnant REs to become mappable as 'non-remnant'" and issue 3 was "a remnant RE can also be cleared to the extent that it becomes mappable as 'non-remnant', notwithstanding that it is capable of regeneration."

Summary of advice regarding fodder issues 2 and 3

1. Require notifications to include spatial details about where within a lot the harvest will occur
2. Reduce the permitted clearing width of strips down to 50 m and increase the width of retained vegetation between strips to be at least 1.5 times the width of the strip
3. Reduce the largest blocks to 1 ha and increase the width of areas to be retained between blocks
4. Limit the area that can be harvested under a single notification
5. Postpone repeat harvest until after 10 years <u>and</u> substantial recovery of height of previously harvested areas (i.e. address issue 1)

Summary of reasons and evidence regarding fodder issues 2 and 3

The question of whether an area will be mapped as non-remnant on the RE mapping depends upon mapping scale, which is set at 1:100 000 for most of Queensland. At this scale the smallest features that are routinely shown on the remnant RE map are 5 ha in area and are at least 75 m wide if they are linear features (Neldner et al 2017b). This means that cleared vegetation in strips greater that 75m wide that cover an area greater than 5 ha can be mapped as non-remnant. So the allowable specifications for strip harvesting under the present code for fodder harvesting are such that they will frequently mapped as non-remnant (135 m wide up to 800m long or more if connectivity can be maintained via non-harvest areas).

The remnant RE map is not directly linked to the VM Act. Instead, it is used to periodically update the map for the VM Act, which is called the Regulated Vegetation Management Map (RVM map). The RVM map can also be updated by property maps of assessable vegetation (PMAVs), which have different scale limits to those described for the remnant RE map.

Of course, when vegetation is cleared, even for fodder harvesting in strips, it does change its height and cover in a way that makes it non-remnant. This is an accepted part of fodder harvesting and is broadly aligned with the purposes of the VM Act provided the fodder areas are allowed to recover to remnant structure (i.e. more than 70% of their pre-clearing height and more than 50% of the pre-clearing cover). The main issue is that non-remnant areas shown on the RE map become category X areas when they are used to update the RVM map, and category X areas are exempt from the VM Act. So if fodder harvesting leads to areas being mapped as non-remnant vegetation it could be used as a loophole to remove vegetation from regulation under the VM Act.

There are several ways in which this issue could be addressed if we knew more precisely where fodder harvesting was being conducted. Currently, landholders must provide the lot and plan identifiers for the land parcel on which harvest will occur. The Herbarium uses this information in updating the remnant mapping in areas prone to fodder harvest to avoid mapping fodder harvesting as non-remnant vegetation as far as practicable. However, this introduces an unwelcome tension into the remnant RE map, because the remnant RE map aims to show what is on the ground as accurately as possible at the relevant map scale. That is, the actual state rather than the regulatory state.

Rather than pushing the boundaries of the remnant RE map, it would be preferable to raise a PMAV when landholders notify DNRME that an area will be subject to fodder harvesting under the code. The PMAV would ensure they were retained as category B (remnant) vegetation on the RVM Map regardless of how they were subsequently mapped on the remnant RE map. Whatever the administrative solution, more detailed spatial information on where codes are being applied is absolutely necessary to ensure that fodder harvesting (and thinning too) does not result in areas becoming exempt from the VM Act because of mapping changes.

Reducing the maximum width of strips for strip fodder harvesting can also reduce the likelihood that such areas will be mapped as non-remnant at the 1:100 000 scale of the remnant RE map. The current (2013) code set the maximum width at 135m, the revised draft code released for consultation in 2016 set the maximum at 100 m, and the lower risk draft developed in December 2017 reduced the maximum to 50 m (Appendix D). This also reduces the risk that 'large areas' are affected by these issues. Narrower strips will result in smaller changes to microclimate and smaller gaps for native biota to traverse, reducing potential impacts on biodiversity and ecosystem function. Narrow gaps are likely to be important to avoiding wind erosion in the highly vulnerable landscapes of the western Mulga Lands and Channel Country (Webb et al. 2006).

A more direct way to reduce the risk of 'large areas' becoming mappable as non-remnant is to restrict the extent of fodder harvesting that can be undertaken under a single notification. The current code requires that fodder harvesting doesn't affect more than 50% of fodder REs on a lot in any 10 year period, and notifications only expire if land changes ownership. We support setting limits per notification and setting an expectation of audit of compliance to reduce the risk of mistaken assumptions or inappropriate methods resulting in poor practice over large areas. Details of the limits and timeframes are in Appendix D.

Fodder issues 4 and 5. Increased number of REs for fodder, inclusion of Endangered and Of Concern REs

Cardno noted that the current code had increased the number of REs that can be fodder harvested from 32 to 53 compared to previous regional vegetation management codes (RVMC) (Issue 4). A related issue (5) is that the REs covered by the 2013 code include Endangered and Of Concern REs.

Summary of advice regarding fodder issues 4 and 5

QH reviewed the REs in the current fodder code and recommended removal of REs with low fodder content for the 2016 draft, and recommended further removal of several Of Concern REs with low fodder value from the selective harvest Table of the December 2017 draft (see Appendix F for details).

Summary of reasons and evidence regarding fodder issues 4 and 5

The fodder code lists REs under two tables to differentiate REs that can be harvested using strip and block practices, from those REs that can only be selectively harvested. QH reviewed the REs in the current code and recommended that some be moved between tables in both directions. We found that most REs in the code are dominated by fodder species and are therefore suitable for harvesting in that regard. The revision for the December 2017 draft aimed to reduce risks of impact on biodiversity and resulted in recommendations to remove 4 of the Of Concern REs from the selective harvest table. These were all REs that tended to occur in fragmented landscapes, where fodder harvesting may exacerbate cumulative pressure from clearing on biodiversity and ecosystem function.

Fodder issue 6. Machinery closer to watercourses and wetlands than in RVMC

The set-backs in the 2013 fodder code are consistent with other codes across the VM framework.

Conclusion

The current thinning and fodder codes were reviewed by Cardno (2015) and found to allow clearing practices that may not be consistent with the purpose of the VM Act or the objectives specified in the codes. The Queensland Herbarium worked with DNRME in their development of draft codes to address the issues identified by Cardno. This document summarises the advice QH provided to DNRME and the evidence base for it. As well as hearing QH advice DNRME have held discussions and negotiation with range of stakeholders and information providers regarding these SACs over the course of two years, and the draft codes reflect a necessary balance between rigour and practicality central to achieving good outcomes.

The Queensland Herbarium provides essential scientific support to the DNRME regarding Queensland's biodiversity and vegetation management. Many of the issues discussed in this report are complex and contentious, and have been the subject of dedicated research, assessment and discussion by Herbarium staff, collaborating scientific institutions, landholders and stakeholders. There has been a recent increase in research on the potential outcomes of thinning and selective clearing on not only production values such as pasture and timber growth, but biodiversity values also. For this document, we have used these to ensure our recommendations are supported by science-based evidence.

We recognise that Queensland's landholders and primary producers are custodians of our collective natural heritage and that the vast majority work towards a Duty of Care; to manage land sustainably. The Herbarium has always been an ally to producers in that effort, providing identification services and supporting biosecurity, working to catalogue and understand Queensland's vegetation, biodiversity and landscapes. The evidence-base for much of this report has been built in collaboration with Queensland's landholder's and primary producers. We are grateful for their continued cooperation.

The recommendations detailed in this document are aimed at improving the ecological outcomes delivered by the revised thinning and fodder harvesting codes, and will also allow the revised codes to be more consistent with the VM Act.

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Appendix A. Letter from Dr Gordon Guymer, Director Queensland Herbarium, to DNRM with initial advice on QH recommendation regarding review of codes for thinning and fodder

Queensland Government

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1st February 2016

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Dear Peter,

Queensland Herbarium recommendations for review of self-assessable codes for fodder harvesting and thinning

This letter summarises recommendations from the Queensland Herbarium in response to issues raised through your Department's review of self-assessable vegetation management codes for fodder harvesting and thinning of thickened vegetation. The Herbarium's recommendations are based on the key premise that self-assessable codes should be restricted to enable only activities that present low risk of negative outcomes for biodiversity and land condition.

Regarding the fodder harvesting code: We agree that the current code risks enabling unsustainable practices by allowing harvest of 'retained' vegetation 10 years after an initial fodder harvest. We recommend that harvest of retained vegetation requires evidence of substantial recovery of vegetation in the initial harvested area. Specifically, harvest of retained vegetation should only occur after 10 years **and** after the harvested vegetation has attained at least 70% of the height of the retained vegetation.

Regarding the thinning code: We discussed four main issues:

1. The extent and causes of thickening in Queensland vegetation
2. The suitability of the definition of mature trees in the current code
3. Required density for retained trees after thinning
4. Regional ecosystems within which thinning is likely to represent a low risk activity

Vegetation thickening has been a contentious issue across Queensland for some time but we have a significant body of published scientific research to support what is happening in Queensland:

a. Changes in woody plant density across the majority of Queensland primarily reflect inter-annual variation in rainfall, so that severe droughts cause rapid and widespread mortality (natural thinning) and woody plant density recovers over ensuing wetter periods (natural thickening) (Fensham *et al.* 2005).

b. Changes in fire regime can affect woody plant density, but most evidence of vegetation thickening associated with reduced fire frequency relates to rainforest expansion into adjacent eucalypt woodlands and forests in eastern Queensland
c. For sub-humid and semi-arid subtropical woodlands, fire frequency is primarily constrained by rainfall, so that fires are common only after wet years (i.e. climate rather than management drives the system)
d. There is little if any evidence in support of grazing as a driver of vegetation thickening

The above points suggest that increasing cover of woody vegetation should be expected as ecosystems recover from tree and shrub death caused by drought. It would be an error to assume that such natural dynamics are some kind of threatening processes requiring intervention. It is therefore a primary concern that the current self-assessable codes for "thinning thickened vegetation" do not require any assessment of the extent of thickening that has occurred on the land before the code can be applied. Instead, thickening is deemed to have occurred everywhere across the State.

To be low risk, we strongly recommend that the self-assessable code for thinning should be restricted to locations where substantial thickening has demonstrably occurred and preferably only to places where evidence suggests thickening goes beyond the typical rate observed in similar ecosystems. We discussed various ways of assessing evidence for thickening, including comparison of historical and recent aerial photography as well as spatial data on trends in persistent green vegetation recently completed by the DSITI's Remote Sensing Centre based on Landsat from 1988 to 2014. The Remote Sensing Centre's product applies established remote sensing techniques (Scarth *et al.* 2010, Flood *et al.* 2013) to the problem of identifying places where thickening may be occurring. We note that a combination of the persistent green trend product with existing regional ecosystem mapping may provide a practical means of applying a revised self-assessable code to regional ecosystems where thinning could be low risk and places where thickening has been occurring in recent decades. We will provide further advice on the outcomes of this approach for your consideration next week.

Regarding mature trees (point 2), the science supports that a self-assessable code for thinning does not affect large trees simply because they are part of a mature regional ecosystem and are therefore not typically indicators of recent thickening. Similarly, their removal is not typically an easily reversed action and is therefore not low risk. The majority of the current self-assessable codes exclude thinning from removing "mature trees" and define them using stem diameter thresholds (30 cm diameter at breast height for eucalypts and 20 cm for all other trees). We agree that these thresholds may not be lower enough for arid regional ecosystems, but recommend against establishing different thresholds for different regions provided our recommended densities for immature tree retention are adopted (discussed below). This is because we judge that the likely benefit of having different thresholds for different regions would not be sufficient to justify the additional complexity. An alternative, that would reduce risk in areas with low numbers of mature trees in all regions, would be to require retention of the twenty largest trees wherever there were less than twenty mature trees per hectare.

The density of immature trees that must be retained after thinning under the current codes is extremely low. The densities also vary widely between regional ecosystems and this creates significant complexity and does not appear to be supported by scientific data. We recommend replacing the retention rates in the current codes with those published by Fensham (2008), which are based on data from native vegetation across Queensland. As well as being supported by science and a peer reviewed publication, the recommended thresholds are far simpler because they take one of only three values depending on the regional ecosystem structure: 50 immature trees per quarter hectare in very sparse REs; 75 immature trees per quarter hectare in sparse REs, and; 125 stems per quarter hectare in mid-dense REs. The spreadsheet that accompanies this letter identifies each RE in the codes as very sparse, sparse or mid-dense.

Lastly, we have reviewed the REs covered by the current codes and identified a significant number (93 of the 493 REs in current codes) for which it is our expert opinion thinning should be considered a high risk activity. These are identified in the accompanying spreadsheet. They fall into four main groups:

1. Regional ecosystems characterised by fire-sensitive dominant species within which thinning is likely to create higher fuel loads and present a significant risk from degradation by fire (primarily in Brigalow Belt bioregion).
2. Riparian and wetland regional ecosystems, especially in arid and semi-arid regions, where thinning presents a high risk of degradation.
3. Endangered regional ecosystems
4. Regional ecosystems characteristic of highly erosion-prone landforms

Several other regional ecosystems were identified where thinning may present moderate risk, but we have not recommended their exclusion at this stage because risks are probably managed by other stipulations within the code. For example, the current codes generally exclude machinery on slopes greater than 10% and from zones around watercourses, prohibit thinning within 5 m of a mature tree, and limit the extent of soil disturbance. These are all important provisions that should be retained.

Yours sincerely

Dr Gordon Guymer
Director
Queensland Herbarium

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Appendix B. Overview of key changes from existing thinning codes (2013/14), revised code for consultation in July 2016, and lower risk options in December 2017

Issues that are primarily a matter of policy are shaded grey

Existing thinning code (2014)	2016 Consultation thinning code	2018 Lower risk option	QH Comments
Five codes based on Bioregions	One code.	One code.	Policy issue
No area limit	Area limit per notification: Coastal areas –10% of the lot, or 200ha (whichever is the lesser); or Non-coastal areas – the lesser of 10% of the lot, or 400ha (whichever is the lesser)	For coastal lots and non-coastal lots where the lot size is 100 hectares or less—10% of the total area of category B regional ecosystems on the lot. For coastal lots where the lot size is greater than 100 hectares—10% of the total area of category B regional ecosystems on the lot or 200 hectares per lot, whichever is the lesser. c. For non-coastal lots where the lot size is greater than 100 hectares—10% of the total area of category B regional ecosystems on the lot or 400 hectares per lot, whichever is the lesser	Area limits reduce risk of poor outcomes from misinterpretation of requirements and avoid potential impact from application of code to large areas. Expressing limits in terms of the area of category B vegetation is more appropriate than relative to lot size. The science presented here indicates the need for a limit to reduce risk, but the choice of limit is a matter of policy.

Existing thinning code (2014)	2016 Consultation thinning code	2018 Lower risk option	QH Comments
489 REs – total remnant extent 65.3 M ha Include regional ecosystems considered endangered and otherwise “high risk” by QH	410 REs – total remnant extent 61.1 M ha Endangered and other “high risk” regional ecosystems have been removed after negotiation. Further restrictions on specific thinning methods in certain regional ecosystem.	332 REs – total remnant extent 55.7 M ha Additional removal of Of Concern REs that had extent <5000ha or are wetlands. See list of regional ecosystems which have been recommended to be excluded justification in Appendix C.	Appendix C has details of REs removed
Prescribed number of immature trees to be retained calculated by DNRME using undocumented method understood to have been based on canopy tree density estimates multiplied by estimated average tree crown areas	Number of immature trees required to be retained based on Fensham (2008b). Densities far higher than in current codes	Number of immature trees required to be retained based on Fensham (2008b).	REs are assigned to canopy cover classes based on their typical structure. Restoring typical densities is the stated aim of thinning in the VM Act. Another objective is the maintenance of remnant status of the vegetation. Some of the retention rates in the current codes (2013/14) may reduce canopy cover below remnant threshold.
No requirement to demonstrate regional ecosystem exceeds a density prescribed threshold prior to notification	Requirement to demonstrate that the regional ecosystem exceeds a density threshold prior to notification	Requirement to demonstrate that the regional ecosystem exceeds a density threshold prior to notification, using three permanent transects per regional ecosystem	Thinning has impacts on biodiversity. If thinning is to address thickening to restore then it should only be where substantial thickening has indeed occurred. Otherwise thinning is not restoration and we’re accepting risks from clearing without the prospect of benefit to biodiversity
Watercourse protection zones for mechanical thinning:	Same as existing (2013/14)	Watercourse protection zones for mechanical thinning: • Wetland – 50 m	One of the objectives of the SAC is to maintain bank stability, water quality and habitat of wetland, watercourse and drainage features. The larger buffer areas

Existing thinning code (2014)	2016 Consultation thinning code	2018 Lower risk option	QH Comments
• Wetland – 20 m • Stream order 1 or 2 – 10 metres • Stream order 3 or 4 – 15 metres • Stream order 5 or more – 20 metres		• Stream order 1 or 2 – 10 metres • Stream order 3 or 4 – 30 metres • Stream order 5 or more – 50 metres	where no mechanical thinning is to occur, provide more protection to the banks, wetlands and water courses.
Notification per property with no end timeframe to notification	Limited to 4 Notifications per lot in any two years (resulting in max 1600 ha thinning / lot)	Limited to 4 Notifications per lot in any two years (resulting in max 1600 ha thinning / lot). Spatial data to be supplied for the area subject to thinning.	Improving the spatial data submitted with notifications will enable checking of REs and trends in woody cover apparent in remote sensing. Data could be captured using a portable GPS device or simply drawing the boundaries on a map either digitally or simply on a paper property map to be digitised at the local government agency and converted into a spatial coverage. This will greatly improve the efficiencies of analysing the purposes for vegetation clearing, and improve the efficiencies of the rapid compliance assessment. This is primarily a policy issue.
No self-audit required	If renotifying, requirement to conduct a self-audit	If renotifying, requirement to conduct a self-audit	
3 transects to measure density of thickened vegetation. Cleared during thinning	5 transects per RE to be thinned to measure density. Cleared during thinning	3 transects per RE to measure density. Must be retained unthinned.	Requiring retention of the vegetation within the transects used to assess pre-thinning density will help reduce risk of poor outcomes for biodiversity by retaining small refuges within the thinned area. It will also improve the evidence

Existing thinning code (2014)	2016 Consultation thinning code	2018 Lower risk option	QH Comments
			base for audits and compliance.
No limit to notification time frame	Landholder can notify up to four times in any two year period of the notification.	Landholder can notify up to two times in any two year period of the notification.	

Appendix C. Regional Ecosystems that were identified as high risk for thinning in January 2016 or subsequently removed from draft code.

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
1.3.5	RE in which understorey trees and shrubs can be thinned	Mixed eucalypt open woodland on sandy alluvial terraces	Sparse	Y	High risk of degradation, occurs on fragile substrates and is not prone to thickening. Recruitment strongly limited by heavy grazing	Least concern	Of concern	y	n	n
1.3.6	RE in which understorey trees and shrubs can be thinned	Corymbia aparrerinja, Corymbia terminalis open woodland on sandy terraces	Sparse	Y	High risk of degradation, occurs on fragile substrates and is not prone to thickening. Recruitment strongly li ited by heavy grazing	Least concern	Of concern	y	n	n
1.3.7	RE in which mechanical thinning is not permitted	Eucalyptus camaldulensis woodland on channels and levees (south)	Sparse	Y	High risk. Ecosystem on banks of water courses in arid region. RE with Endangered biodiversity status	Least concern	Endangered	y	n	n
1.3.8	RE in which mechanical thinning is not permitted	Eucalyptus camaldulensis woodland on channels and levees (north)	Sparse	Y	High risk. Ecosystem on banks of water courses in arid region. RE with Endangered biodiversity status	Least concern	Endangered	y	n	n
2.3.13	RE in which mechanical thinning is not permitted	Acacia stenophylla low woodland in seasonal swamps on grey clay plains	Mid-dense	Y	High risk of degradation, wetland with high environmental and cultural values, rare ecosystem type and no evidence of thickening noted by mappers	Of concern	Of concern	y	n	n
2.3.33	RE in which mechanical thinning is not permitted	Eucalyptus microtheca open woodland and sedges in circular depressions in sand plains, on cracking clays	Very sparse		Riverine or palustrine wetland, prohibit mechanical thinning	Least concern	Of concern	y	n	n
2.3.37	RE in which understorey trees and shrubs can be thinned	Eucalyptus platyphylla and Eucalyptus brownii woodland in shallow depressions on plateaus, on podsolics and earths	Sparse			Of concern	Of concern	y	n	n
3.3.15	RE in which understorey trees and shrubs can be thinned	Eucalyptus brassiana woodland on alluvial plains	Sparse			Of concern	Of concern	n	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
3.3.45	RE in which understorey trees and shrubs can be thinned	Eucalyptus chlorophylla +/- Melaleuca viridiflora low open woodland on Mitchell River floodplain	Very sparse			Of concern	Of concern	y	n	n
3.5.26	RE in which understorey trees and shrubs can be thinned	Eucalyptus platyphylla +/- Corymbia clarksoniana woodland to open forest on flat wet plains	Sparse			Least concern	Of concern	y	n	n
3.5.31	RE in which understorey trees and shrubs can be thinned	Corymbia clarksoniana +/- Erythrophleum chlorostachys woodland on coastal plains	Sparse			Of concern	Of concern	n	n	n
3.8.3	RE in which understorey trees and shrubs can be thinned	Eucalyptus leptophleba or Corymbia clarksoniana +/- C. tessellaris woodland on basalt flows	Sparse		Moderate risk of degradation through weed invasion following disturbance, endangered biodiversity status	Of concern	Endangered	y	n	n
3.12.13	RE in which understorey trees and shrubs can be thinned	Corymbia nesophila and C. stockeri subsp. peninsularis woodland on acid volcanic hills	Sparse		Moderate risk of degradation on steeper areas (eg. Slope >10 degrees)	Least concern	Of concern	n	n	n
4.3.1	RE in which immature trees and tall shrubs can be thinned	Eucalyptus camaldulensis +/- Melaleuca spp. woodland on drainage lines	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	n	n	n
4.3.2	RE in which immature trees and tall shrubs can be thinned	Eucalyptus camaldulensis +/- E. coolabah woodland on drainage lines	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	n	n	n
4.3.3	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah, E. camaldulensis +/- Lysiphyllum gilvum open woodland on drainage lines	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	n	n	n
4.3.4	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah open woodland on drainage lines and/or plains	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
4.3.5	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah +/- E. camaldulensis +/- Acacia georginae open woodland on drainage lines and/or plains	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	n	n	n
4.3.6	RE in which immature trees and tall shrubs can be thinned	Atalaya hemiglauca +/- Acacia georginae +/- Acacia cyperophylla var. cyperophylla woodland on alluvium	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk. Naturally shrubby	Least concern	No concern at present	n	n	n

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4.3.11	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah +/- E. camaldulensis open woodland on alluvium, billabongs and permanent waterholes	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
5.3.1	RE in which immature trees and tall shrubs can be thinned	Eucalyptus camaldulensis +/- Melaleuca spp. woodland on levees and banks of major rivers	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.2	RE in which immature trees and tall shrubs can be thinned	Eucalyptus camaldulensis +/- E. coolabah open woodland on levees and banks of drainage lines	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.4	RE in which immature trees and tall shrubs can be thinned	Eucalyptus camaldulensis +/- Atalaya hemiglauca +/- Acacia cambagei +/- Acacia georginae +/- Acacia cyperophylla var. cyperophylla woodland on drainage lines within ranges	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.5	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah open woodland with Duma florulenta shrubland on braided channel systems	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.6	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah open woodland on alluvial plains	Very sparse	Y	high risk, generally a very sparse woodland, recruitment dependent on very infrequent flooding, producing even aged stands with very high attrition rates of recruits because of natural episodes of extreme aridity	Least concern	No concern at present	y	n	n
5.3.7	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah +/- Lysiphyllum gilvum +/- Acacia cambagei low open woodland on drainage lines	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.8	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah low open woodland with Duma florulenta on braided drainage lines	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n
5.3.9	RE in which immature trees and tall shrubs can be thinned	Acacia cambagei +/- Eucalyptus coolabah low woodland on braided channels	Sparse	Y	high risk, riverine fringing, high erosional risk	Least concern	No concern at present	y	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
5.3.10	RE in which immature trees and tall shrubs can be thinned	Acacia cambagei low open woodland +/- Senna artemisioides subsp. oligophylla +/- Eremophila spp. on alluvium	Very sparse	Y	high risk, riverine fringing steep slopes, very high erosional risk	Least concern	No concern at present	y	n	n
5.3.11	RE in which immature trees and tall shrubs can be thinned	Acacia georginae tall shrubland with Senna artemisioides subsp. oligophylla +/- Eremophila freelingii on alluvium	Sparse	Y	high risk, generally very sparse woodland, recruitment dependent on very infrequent flooding and with high attrition rates because of normally arid environment,	Least concern	No concern at present	y	n	n
5.3.20	RE in which immature trees and tall shrubs can be thinned	Eucalyptus coolabah +/- Eucalyptus camaldulensis open woodland fringing billabongs and permanent waterholes	Very sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
5.7.6	RE in which immature trees and tall shrubs can be thinned	Acacia cambagei low open woodland with Triodia spp. +/- Senna spp. on eroding pediments	Sparse	Y	high risk, erosional risk as occurs on eroding pediment slopes	Least concern	No concern at present	y	n	n
5.7.8	RE in which immature trees and tall shrubs can be thinned	Acacia peuce low open woodland between dunes	Very sparse	Y	Ecosystem dominated by a listed threatened species	Of concern	Endangered	n	n	n
6.3.1	RE in which thinning of trees and tall shrubs can occur	Eucalyptus camaldulensis woodland on alluvium within Acacia aneura associations	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
6.3.2	RE in which thinning of trees and tall shrubs can occur	Eucalyptus camaldulensis +/- E. coolabah +/- Acacia cambagei woodland on major drainage lines or rivers	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
6.3.3	RE in which thinning of trees and tall shrubs can occur	Eucalyptus camaldulensis +/- E. coolabah +/- E. populnea, Acacia stenophylla woodland on alluvium	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
6.3.4	RE in which thinning of trees and tall shrubs can occur	Acacia cambagei +/- Eucalyptus ochrophloia woodland on alluvium	Sparse	Y	Fire sensitive and prone to weed invasion following disturbance	Least concern	No concern at present	y	n	n
6.3.6	RE in which thinning of trees and tall shrubs can occur	Acacia cambagei low woodland on braided channels or alluvial plains	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	No concern at present	y	n	n

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6.3.8	RE in which thinning of trees and tall shrubs can occur	Eucalyptus largiflorens +/- Acacia cambagei woodland on alluvium	Sparse	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
6.3.12	RE in which thinning of trees and tall shrubs can occur	Acacia omalophylla +/- A. microsperma +/- Eucalyptus coolabah tall open shrubland on alluvium	Mid-dense	Y	High risk. Riverine fringe in arid zone. Episodic recruitment, high erosional risk	Least concern	Of concern	y	n	n
6.3.17	RE in which thinning of trees and tall shrubs can occur	Callitris glaucophylla, Corymbia tessellaris, Acacia excelsa +/- C. clarksoniana open woodland on old alluvial dunes and sand plains	Very sparse			Least concern	Of concern	y	n	n
6.3.25	RE in which thinning of trees and tall shrubs can occur	Acacia harpophylla and/or A. cambagei low woodland to woodland on alluvial plains	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	No concern at present	y	n	n
6.4.1	RE in which thinning of trees and tall shrubs can occur	Acacia cambagei +/- Casuarina cristata low open forest on clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	n
6.4.2	RE in which thinning of trees and tall shrubs can occur	Casuarina cristata +/- Acacia harpophylla open forest on clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	n
6.4.3	RE in which thinning of trees and tall shrubs can occur	Eucalyptus populnea, Casuarina cristata or Acacia harpophylla +/- Geijera parviflora woodland on clay plains	Sparse	Y	High risk. Endangered biodiversity status RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Of concern	Endangered	y	n	n
6.4.4	RE in which thinning of trees and tall shrubs can occur	Acacia harpophylla and/or A. cambagei low woodland on Quaternary deposits overlying older sediments	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	No concern at present	y	n	n
6.5.5	RE in which thinning of trees and tall shrubs can occur	Eucalyptus populnea +/- E. intertexta +/- Acacia aneura +/- Callitris glaucophylla woodland on Quaternary sediments	Sparse			Of concern	Endangered	y	n	n
6.7.5	RE in which thinning of trees and tall shrubs can occur	Eucalyptus thozetiana or E. cambageana, Acacia harpophylla woodland on scarps	Sparse	Y	High risk. Fire sensitive and erosion prone landform	Least concern	Of concern	y	n	n
6.9.3	RE in which thinning of trees and tall shrubs can occur	Acacia harpophylla woodland with emergent Eucalyptus cambageana with stony soils derived from Cretaceous sediments	Sparse	Y	High risk. Fire sensitive vegetation prone to weed invasion following disturbance	Least concern	Of concern	y	n	n

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6.9.4	RE in which thinning of trees and tall shrubs can occur	Acacia cambagei, Senna spp., Sida platycalyx tall open shrubland on undulating mantled pediments and scarp retreat zones	Mid-dense	Y	High risk. Fire sensitive vegetation prone to weed invasion following disturbance, erosion prone landform	Least concern	No concern at present	y	n	n
6.12.1	RE in which thinning of trees and tall shrubs can occur	Scattered Acacia aneura around granite boulders	Mid-dense			Of concern	Of concern	n	n	n
7.3.14	RE in which understorey trees and shrubs can be thinned	Eucalyptus leptophleba +/- Corymbia clarksoniana +/- Melaleuca dealbata woodland to open forest on alluvium in low rainfall areas of the west and north	Sparse		Moderate risk. Contains shrubland dominated vegetation community.	Of concern	Of concern	y	n	n
7.3.16	RE in which mechanical thinning is not permitted	Eucalyptus platyphylla woodland to open forest on alluvial plains	Mid-dense			Least concern	Endangered	y	n	n
7.3.39	RE in which mechanical thinning is not permitted	Eucalyptus tereticornis +/- E. platyphylla +/- Corymbia intermedia +/- Lophostemon suaveolens open woodland to open forest, and associated sedgelands and grasslands on broad drainage depressions of uplands	Mid-dense		Moderate risk. 2 sites which show this unit as mid dense rather than very sparse. While the T2 and T3 component is variable it appears to form a characteristic part of the community	Of concern	Endangered	y	n	n
7.5.4	RE in which understorey trees and shrubs can be thinned	Corymbia intermedia or Melaleuca viridiflora woodland to open forest of uplands on weathered soils of a remnant surface	Mid-dense		Stanton mapping notes indicate this is mid-dense rather than sparse. Thinning of canopy layers will allow invasion particularly of Lantana.	Of concern	Of concern	y	n	n
7.11.20	RE in which understorey trees and shrubs can be thinned	Corymbia nesophila, Corymbia clarksoniana, Eucalyptus platyphylla open woodland to open forest on gently sloping metamorphic lowlands and foothills	Dense	Y	High risk. Site data show this as having a consistently 'dense' T2 and T3 layer which appears to form a characteristic part of the community. Sites were done in early '90s	Least concern	No concern at present	n	n	n
7.11.37	RE in which understorey trees and shrubs can be thinned	Eucalyptus drepanophylla and Corymbia clarksoniana or C. erythrophloia woodland to open forest on dry uplands on metamorphics between Tolga and Mount Molloy	Sparse			Of concern	Of concern	y	n	n

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7.11.41	RE in which mechanical thinning is not permitted	Melaleuca viridiflora, M. monantha, Acacia flavescens, and Grevillea spp. shrubland, with emergent Corymbia clarksoniana, or open woodland of Eucalyptus drepanophylla with M. monantha or Callitris intratropica, on metamorphics	mid dense		Moderate risk. Stanton notes indicate the shrub layer and low T2 layer is a distinctive component of this RE.	Of concern	Of concern	n	n	n
7.11.42	RE in which mechanical thinning is not permitted	Eucalyptus tereticornis, Pandanus sp., Lophostemon suaveolens, Melaleuca dealbata and E. pellita woodland to open forest of perched drainage areas on metamorphics	Sparse	Y	High risk. Wetland RE with endangered biodiversity status	Of concern	Endangered	n	n	n
7.11.48	RE in which mechanical thinning is not permitted	Melaleuca viridiflora +/- Corymbia clarksoniana +/- Eucalyptus platyphylla woodland to open forest on metamorphics	Sparse			Of concern	Endangered	n	n	n
7.11.50	RE in which understorey trees and shrubs can be thinned	Eucalyptus platyphylla +/- E. drepanophylla +/- Corymbia spp. open woodland to open forest on metamorphics	Sparse			Of concern	Of concern	y	n	n
7.12.33	RE in which understorey trees and shrubs can be thinned	Corymbia nesophila woodland to open forest on granite	Mid-dense		Moderate risk. Sites show this as mid-dense rather than sparse and that the T2 shrub layer are a characteristic part of the community	Of concern	Of concern	y	n	n
7.12.60	RE in which mechanical thinning is not permitted	Melaleuca viridiflora +/- Corymbia clarksoniana +/- Eucalyptus platyphylla woodland to open forest on granite and rhyolite	Sparse			Of concern	Endangered	y	n	n
7.12.62	RE in which understorey trees and shrubs can be thinned	Eucalyptus sp., and/or Corymbia stockeri, +/- C. hylandii +/- Syncarpia glomulifera +/- E. portuensis woodland, on dry granite hill slopes in the north-west of the bioregion	Sparse			Of concern	Of concern	y	n	n
7.12.63	RE in which understorey trees and shrubs can be thinned	Eucalyptus moluccana woodland on granite and rhyolite	Sparse			Of concern	Endangered	n	n	n

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7.12.69	RE in which understorey trees and shrubs can be thinned	Eucalyptus drepanophylla and/or E. granitica +/- Corymbia clarksoniana +/- C. erythrophloia woodland on uplands on granite and rhyolite	Sparse			Of concern	Of concern	y	n	n
8.11.4	RE in which trees and shrubs can be thinned	Eucalyptus platyphylla and/or Corymbia clarksoniana and/or C. intermedia and/or C. tessellaris woodland on low undulating areas on metamorphosed sediments	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
8.12.23	RE in which trees and shrubs can be thinned	Eucalyptus moluccana woodland on elevated tablelands on Mesozoic to Proterozoic igneous rocks	Sparse			Of concern	Of concern	y	n	n
9.3.15	RE in which mechanical thinning is not permitted	Eucalyptus tereticornis +/- Casuarina cunninghamiana +/- Melaleuca spp. fringing woodland on channels and levees	Mid-dense	y	High risk of degradation from thinning this ecosystem fringing watercourses. Opening canopy will increase risk of weed invasion and may cause problems with erosion	Least concern	Of concern	y	n	n
9.3.17	RE in which mechanical thinning is not permitted	Casuarina cunninghamiana and/or Eucalyptus camaldulensis or E. tereticornis fringing open forest on channels and levees on basalt flows	Mid-dense			Least concern	Of concern	y	n	n
9.8.12	RE in which understorey trees and shrubs can be thinned	Excoecaria parvifolia low open woodland on cracking clays on rocky basalt plains	Sparse			Of concern	Of concern	y	n	n
10.3.1	RE in which only shrubs can be thinned	Acacia argyrodendron low open woodland on alluvial plains (western)	Very sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
10.3.2	RE in which only shrubs can be thinned	Acacia argyrodendron with or without Eucalyptus cambageana open woodland on alluvial plains (eastern)	Very sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
10.3.3	RE in which only shrubs can be thinned	Acacia harpophylla and/or Eucalyptus cambageana low open woodland to open woodland on alluvial plains	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	No concern at present	n	n	y
10.3.4	RE in which only shrubs can be thinned	Acacia cambagei low open woodland to low woodland on alluvial plains	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y

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10.3.19	RE in which trees and shrubs can be thinned	Acacia cambagei woodland on lakeside dunes	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	y
10.3.20	RE in which trees and shrubs can be thinned	Eucalyptus melanophloia open woodland on older lake-fringing dunes	Sparse			Of concern	Of concern	n	n	n
10.3.21	RE in which trees and shrubs can be thinned	Acacia salicina and Grevillea striata low open woodland on sandy alluvial plains	Very sparse			Of concern	Endangered	y	n	n
10.3.25	RE in which trees and shrubs can be thinned	Eremophila mitchellii tall open shrubland on alluvial plains	Very sparse			Least concern	Endangered	y	n	n
10.4.1	RE in which only shrubs can be thinned	Acacia argyrodendron open woodland on Cainozoic lake beds	Very sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
10.4.2	RE in which only shrubs can be thinned	Acacia harpophylla low woodland on Cainozoic lake beds (subregion 3)	Very sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Of concern	Of concern	n	n	y
10.4.3	RE in which only shrubs can be thinned	Acacia harpophylla and/or Eucalyptus cambageana open woodland on Cainozoic lake beds	Sparse	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, endangered biodiversity status	Least concern	Endangered	n	n	y
10.4.4	RE in which only shrubs can be thinned	Acacia cambagei woodland on Cainozoic lake beds (subregion 3)	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Of concern	Of concern	n	n	y
10.4.5	RE in which only shrubs can be thinned	Acacia cambagei low woodland on Cainozoic lake beds	Very sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
10.4.6	RE in which only shrubs can be thinned	Terminalia oblongata and Lysiphyllum carronii low open woodland on Cainozoic lake beds	Very sparse			Of concern	Endangered	n	n	y
10.4.9	RE in which trees and shrubs can be thinned	Corymbia spp. open woodland on Cainozoic lake beds	Very sparse			Of concern	Endangered	n	n	n
10.5.1	RE in which thinning can only occur by controlled burn	Eucalyptus similis and/or Corymbia brachycarpa and/or Corymbia setosa low open woodland on sand plains	Very sparse			Least concern	No concern at present	n	n	n
10.5.2	RE in which thinning can only occur by controlled burn	Corymbia plena with or without C. dallachiana or C. terminalis open woodland on sand plains	Very sparse			Least concern	No concern at present	n	n	n

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10.5.7	RE in which thinning can only occur by controlled burn	Grevillea striata, G. parallela and Acacia sericophylla low open woodland or Corymbia terminalis open woodland on relict sand plain	Very sparse			Least concern	Of concern	n	n	n
10.5.10	RE in which thinning can only occur by controlled burn	Corymbia leichhardtii open woodland on sand plains	Very sparse			Least concern	No concern at present	n	n	n
10.5.11	RE in which thinning can only occur by controlled burn	Eucalyptus whitei or E. melanophloia open woodland on red sand plateaus	Very sparse			Least concern	No concern at present	n	n	n
10.7.2	RE in which thinning can only occur by controlled burn	Eucalyptus persistens or Corymbia dallachiana low open woodland or Triodia pungens hummock grassland on ferricrete above scarps	Very sparse			Least concern	No concern at present	n	n	n
10.7.5	RE in which thinning can only occur by controlled burn	Eucalyptus thozetiana open woodland on scarps and on pediments below scarps	Sparse		Moderate risk, erosion prone landform	Least concern	Of concern	n	n	n
10.7.10	RE in which thinning can only occur by controlled burn	Eucalyptus whitei open woodland or Corymbia setosa low open woodland on ferricrete	Very sparse			Least concern	No concern at present	n	n	n
10.9.1	RE in which only shrubs can be thinned	Acacia argyrodendron low open woodland or dwarf open shrubland of chenopods or scald on Cretaceous sediments	Very sparse			Least concern	Of concern	n	n	y
10.9.2	RE in which only shrubs can be thinned	Acacia cambagei and/or Eucalyptus thozetiana low woodland to open woodland on calcareous sandstones	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
10.9.3	RE in which only shrubs can be thinned	Acacia harpophylla and/or Eucalyptus cambageana open woodland to woodland on Mesozoic sediments	Sparse	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, endangered biodiversity status	Least concern	Endangered	n	n	y
10.9.6	RE in which only shrubs can be thinned	Acacia cambagei low woodland on Cretaceous sediments	Very sparse			Least concern	Of concern	y	n	n
10.10.3	RE in which trees and shrubs can be thinned	Eucalyptus drepanophylla open woodland on sandstone ranges	Very sparse			Of concern	Of concern	y	n	n

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11.3.1	RE in which only shrubs can be thinned	Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.3.2	RE in which trees and shrubs can be thinned	Eucalyptus populnea woodland on alluvial plains	Sparse			Of concern	Of concern	y	n	n
11.3.3	RE in which trees and shrubs can be thinned	Eucalyptus coolabah woodland on alluvial plains	Sparse			Of concern	Of concern	y	n	n
11.3.5	RE in which only shrubs can be thinned	Acacia cambagei woodland on alluvial plains	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
11.3.8	RE in which only shrubs can be thinned	Acacia argyrodendron woodland on alluvial plains	Sparse	Y	High risk. Fire sensitive and prone to weed invasion following disturbance	Least concern	Of concern	n	n	y
11.3.13	RE in which trees and shrubs can be thinned	Grevillea striata open woodlands on coastal alluvial plains	Very sparse			Of concern	Endangered	y	n	n
11.3.15	RE in which trees and shrubs can be thinned	Eucalyptus coolabah, Acacia stenophylla, Duma florulenta fringing open woodland on alluvial plains	Very sparse			Of concern	Of concern	y	n	n
11.3.16	RE in which trees and shrubs can be thinned	Eucalyptus largiflorens +/- Acacia cambagei +/- A. harpophylla woodland to low open woodland on alluvial plains	Very sparse			Least concern	No concern at present	y	n	n
11.3.17	RE in which only shrubs can be thinned	Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains	Sparse			Of concern	Endangered	n	n	y
11.3.23	RE in which trees and shrubs can be thinned	Eucalyptus conica, E. nobilis, E. tereticornis, Angophora floribunda woodland on alluvial plains. Basalt derived soils	Sparse	Y	High risk. Wetland RE with endangered biodiversity status	Of concern	Endangered	n	n	n
11.3.25	RE in which trees and shrubs can be thinned	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Mid-dense	Y	High risk of degradation - highly erodible, ecosystem occurs along banks of creeks and rivers	Least concern	Of concern	y	n	n
11.3.28	RE in which trees and shrubs can be thinned	Eucalyptus coolabah +/- Casuarina cristata open woodland on alluvial plains	Very sparse			Of concern	Of concern	y	n	n
11.3.33	RE in which trees and shrubs can be thinned	Eremophila mitchellii open woodland on alluvial plains	Very sparse	Y	High risk of degradation - highly sodic and erodible soils, and extremely localised RE	Of concern	Endangered	n	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
11.3.37	RE in which trees and shrubs can be thinned	Eucalyptus coolabah fringing woodland on alluvial plains	Sparse	Y	High risk of degradation - highly erodible, ecosystem occurs along banks of creeks and rivers	Least concern	No concern at present	y	n	n
11.3.38	RE in which trees and shrubs can be thinned	Eucalyptus tereticornis, Melaleuca viridiflora, Corymbia tessellaris and Eucalyptus fibrosa subsp. fibrosa tall woodland with a grassy ground layer on alluvial plains and broad drainage lines derived from serpentinite	Mid-dense	Y	High risk. Endangered RE. If thinning permitted suggest restricting thinning to shrubs only (probably of Melaleuca viridiflora only). Highly restricted RE in northern Rockhampton area	Endangered	Endangered	n	n	n
11.4.3	RE in which only shrubs can be thinned	Acacia harpophylla and/or Casuarina cristata shrubby open forest on Cainozoic clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.4.5	RE in which only shrubs can be thinned	Acacia argyrodendron woodland on Cainozoic clay plains	Sparse	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, endangered biodiversity status	Of concern	Endangered	n	n	y
11.4.6	RE in which only shrubs can be thinned	Acacia cambagei woodland on Cainozoic clay plains	Dense	Y	High risk. Dense fire-sensitive RE prone to degradation if canopy cover reduced, also endangered biodiversity status	Of concern	Endangered	n	n	y
11.4.7	RE in which only shrubs can be thinned	Eucalyptus populnea with Acacia harpophylla and/or Casuarina cristata open forest to woodland on Cainozoic clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.4.8	RE in which only shrubs can be thinned	Eucalyptus cambageana woodland to open forest with Acacia harpophylla or A. argyrodendron on Cainozoic clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.4.9	RE in which only shrubs can be thinned	Acacia harpophylla shrubby woodland with Terminalia oblongata on Cainozoic clay plains	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.4.10	RE in which trees and shrubs can be thinned	Eucalyptus populnea or E. woollsiana, Acacia harpophylla, Casuarina cristata open forest to woodland on margins of Cainozoic clay plains	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	y

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
11.4.12	RE in which trees and shrubs can be thinned	Eucalyptus populnea woodland on Cainozoic clay plains	Mid-dense	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
11.4.13	RE in which trees and shrubs can be thinned	Eucalyptus orgadophila open woodland on Cainozoic clay plains	Very sparse			Least concern	Endangered	y	n	n
11.7.5	RE in which only shrubs can be thinned	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks	Dense	Y	High risk of degradation - very patchy ecosystem with very thin soils, on edge of lateritic surfaces	Least concern	No concern at present	n	n	y
11.8.2	RE in which trees and shrubs can be thinned	Eucalyptus tereticornis, E. melliodora woodland on Cainozoic igneous rocks	Sparse			Least concern	No concern at present	y	n	n
11.8.8	RE in which trees and shrubs can be thinned	Eucalyptus albens, E. crebra woodland on Cainozoic igneous rocks	Sparse			Least concern	No concern at present	y	n	n
11.8.15	RE in which trees and shrubs can be thinned	Eucalyptus brownii or Eucalyptus populnea woodland on Cainozoic igneous rocks	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
11.9.1	RE in which only shrubs can be thinned	Acacia harpophylla-Eucalyptus cambageana woodland to open forest on fine-grained sedimentary rocks	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.9.9	RE in which trees and shrubs can be thinned	Eucalyptus crebra woodland on fine-grained sedimentary rocks	Sparse			Least concern	No concern at present	y	n	n
11.9.10	RE in which only shrubs can be thinned	Eucalyptus populnea open forest with a secondary tree layer of Acacia harpophylla and sometimes Casuarina cristata on fine-grained sedimentary rocks	Mid-dense	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, also RE with Endangered biodiversity status that naturally contains dense patches	Of concern	Endangered	n	n	n
11.9.11	RE in which only shrubs can be thinned	Acacia harpophylla shrubland on fine-grained sedimentary rocks	Mid-dense	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, RE naturally contains dense patches	Of concern	Of concern	n	n	y
11.9.14	RE in which trees and shrubs can be thinned	Lysiphyllum carronii, Atalaya hemiglauca +/- Eucalyptus melanophloia +/- Acacia excelsa open woodland	Very sparse			Of concern	Endangered	y	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
11.11.13	RE in which only shrubs can be thinned	Acacia harpophylla or A. argyrodendron low open forest with a secondary tree layer of Terminalia oblongata on deformed and metamorphosed sediments and interbedded volcanics	Mid-dense	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, RE naturally contains dense patches	Of concern	Of concern	n	n	y
11.11.14	RE in which only shrubs can be thinned	Acacia harpophylla open forest on deformed and metamorphosed sediments and interbedded volcanics	Mid-dense	Y	High risk. Endangered RE, also fire sensitive vegetation with high risk of degradation if canopy disrupted	Endangered	Endangered	n	n	y
11.11.16	RE in which trees and shrubs can be thinned	Eucalyptus cambageana, Acacia harpophylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	Mid-dense	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, RE naturally contains dense patches	Of concern	Of concern	n	n	y
11.11.19	RE in which only shrubs can be thinned	Eucalyptus thozetiana, Acacia harpophylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding	Sparse	Y	High risk. Fire sensitive vegetation with high risk of degradation if canopy disrupted, RE naturally contains dense patches	Least concern	Of concern	n	n	y
11.12.14	RE in which trees and shrubs can be thinned	Lophostemon spp. woodland on igneous rocks. Coastal hills	Mid-dense	Y	High risk of degradation - RE is restricted to very rocky mountaintops and steep hillsides only	Of concern	Of concern	y	n	n
11.12.17	RE in which trees and shrubs can be thinned	Eucalyptus populnea woodland on igneous rocks. Colluvial lower slopes	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
12.3.10	RE in which thinning can occur	Eucalyptus populnea woodland on alluvial plains	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
12.5.5	RE in which thinning can occur	Eucalyptus portuensis, Corymbia intermedia open forest on remnant Tertiary surfaces. Usually deep red soils	Mid-dense			Of concern	Of concern	y	n	n
12.5.8	RE in which thinning can occur	Eucalyptus hallii open woodland on complex of remnant Tertiary surface and Tertiary sedimentary rocks	Very sparse			Of concern	Of concern	y	n	n
12.5.11	RE in which thinning can occur	Syncarpia glomulifera woodland on complex of remnant Tertiary surface and Tertiary sedimentary rocks	Mid-dense	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
12.8.20	RE in which thinning can occur	Shrubby woodland with Eucalyptus racemosa subsp. racemosa or E. dura on Cainozoic igneous rocks	Mid-dense	Y	High risk. Naturally shrubby ecosystem, not suited to thinning. High risk of degradation on skeletal soils	Of concern	Of concern	y	y	n
12.8.26	RE in which thinning can occur	Corymbia trachyphloia and Eucalyptus major woodland on igneous rocks	Mid-dense			Of concern	Of concern	n	n	n
12.9-10.8	RE in which thinning can occur	Eucalyptus melanophloia, E. crebra woodland on sedimentary rocks	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
12.9-10.13	RE in which thinning can occur	Eucalyptus corynodes woodland on sedimentary rocks	Sparse			Of concern	Of concern	n	n	n
12.9-10.24	RE in which thinning can occur	Eucalyptus suffulgens open forest on sedimentary rocks	Mid-dense			Of concern	Of concern	y	n	n
12.11.20	RE in which thinning can occur	Corymbia intermedia, Lophostemon suaveolens woodland on metamorphics +/- interbedded volcanics	Sparse			Of concern	Of concern	y	n	n
12.11.21	RE in which thinning can occur	Allocasuarina luehmannii, Melaleuca nervosa woodland on metamorphics +/- interbedded volcanics	Very sparse			Of concern	Of concern	y	n	n
12.12.14	RE in which thinning can occur	Eucalyptus racemosa subsp. racemosa +/- Lophostemon confertus, Syncarpia glomulifera, Eucalyptus acmenoides woodland usually on rocky near coastal areas on Mesozoic to Proterozoic igneous rocks	Sparse			Of concern	Of concern	y	n	n
12.12.21	RE in which thinning can occur	Corymbia intermedia, E. exserta woodland on Mesozoic to Proterozoic igneous rocks	Sparse			Of concern	Of concern	y	n	n
13.3.1	RE in which thinning can occur	Eucalyptus blakelyi woodland on alluvial plains	Sparse	Y	High risk. Endangered RE & wetland	Endangered	Endangered	n	n	n
13.3.2	RE in which thinning can occur	Eucalyptus nova-anglica open forest on alluvial plains	Mid-dense	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
13.3.4	RE in which thinning can occur	Eucalyptus conica, E. microcarpa, E. melliodora woodland on alluvial plains	Sparse	Y	High risk. Endangered RE & wetland	Endangered	Endangered	n	n	n
13.12.3	RE in which thinning can occur	Eucalyptus scoparia woodland on igneous rocks	Sparse			Of concern	Of concern	n	n	n

RE	Current SACs (2013/14)	RE short description	Structure category	Identified as high risk Jan 2016?	Comment	RE VM Class	RE biodiversity status	in revised 2016?	in revised 2018?	SDAP Module 8
13.12.8	RE in which thinning can occur	Eucalyptus melliodora and/or E. moluccana and/or E. microcarpa and/or E. conica woodland on igneous rocks	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
13.12.9	RE in which thinning can occur	Eucalyptus blakelyi and/or E. caliginosa woodland to open forest on igneous rocks	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n
13.12.10	RE in which thinning can occur	Eucalyptus crebra, E. tereticornis, Angophora leiocarpa woodland on igneous rocks	Sparse	Y	High risk. Endangered RE	Endangered	Endangered	n	n	n

Appendix D. Overview of key changes from existing fodder harvesting codes (2013/14), revised code for consultation in July 2016, and lower risk options in December 2017

Issues that are primarily a matter of policy are shaded grey

Existing fodder code	2016 Consultation fodder code	2018 draft code	Justification
No area limit but no more than 50% of fodder on lot harvested within 10 years	Area limit of 500 hectares (including both harvested and retained areas) and no more than 50% of fodder on lot harvested within 10 years	Area limit of 500 hectares (including both harvested and retained areas) and no more than 50% of fodder on lot harvested within 10 years	An objective of the SAC is provision of necessary for stock only. Smaller area limits reduce the risk of wastage of fodder because the rate of harvest exceeds an amount necessary to supply the required fodder for feeding the number of stock on the lot, should not occur. This limit is a policy decision.
Notification per property with no end timeframe to notification	No limit on notifications per lot. Notification period is limited to two years	You may make a second notification for fodder harvesting on a lot within the two year notification period, subject to undertaking a self-audit of the area that has been fodder harvested, and the results of the self-audit indicating that your thinning harvesting is consistent with practices in this code requirements	
No self-audit required	If renotifying requirement to conduct a self-audit	If renotifying requirement to conduct a self-audit	Reduce risk of costly misinterpretations
Incudes regional ecosystems with species that have little or no value as a fodder resource	Regional ecosystems with little or no value as a fodder resource have been removed.	Regional ecosystems with little or no value as a fodder resource have been removed.	An objective of the SAC is provision of food necessary for stock, if very low density of fodder trees then it is economically unviable to fodder harvest.
Selective, strip and block harvesting methods permitted.	Strip harvesting practices simplified and	Strip harvesting practices simplified and block harvesting is limited to a	

Block is limited to 1 to 4 ha No strip or block harvesting in REs smaller than 10ha or less than 500m wide	block harvesting is limited to a maximum 1 hectare. No strip or block harvesting in REs smaller than 10ha or less than 500m wide	maximum 1 hectare. No strip or block harvesting in REs smaller than 10ha or less than 500m wide	
Maximum strip width 135m	Maximum strip width – 100m	Maximum strip width – 50m	This is below the minimum width detected in the RE mapping program. The area will remain mapped as remnant. Maintenance of remnant status is an objective of the SAC.
Minimum vegetation retention requirements to ensure a minimum vegetation retention rate of 60%.	Vegetation retention requirements for strip and block harvesting designed to ensure a minimum vegetation retention rate of 60%.	Vegetation retention requirements for strip and block harvesting designed to ensure a minimum vegetation retention rate of 60%.	Maintain remnant extent and minimise fragmentation
Minimum 10 year intervals between harvests	Minimum 10 year intervals between harvests PLUS minimum tree height (70% of the tallest stands of fodder retained) to assist in regeneration to remnant status	Where fodder harvesting occurred previously in an area of a lot, harvesting may only occur if: a. The fodder harvesting occurred more than 10 years ago; and b. the average height of the fodder trees is at least 70 per cent of the height of the tallest stands of fodder species in the regional ecosystem; and c. the fodder trees in the area that were previously harvested have now attained an average height of at least 4 metres.	The reported height-growth rates of mulga in Queensland range from 22 cm yr-1 to a maximum of 41 cm yr-1 (ungrazed during wet periods). Hence over 10 years mulga can only be expected to grow to a maximum of four metres in the best of conditions. This is provided climate conditions and lack of grazing pressure allow new mulga plants to germinate, grow and establish. Grazing can keep mulga short, so need criteria to limit re-harvest until previously harvested area has substantially recovered.

• No selective harvesting within 20 m of any watercourse or wetland • No strip or block harvesting within 100 m of any watercourse or wetland	Same as existing	Same as existing	
No practice specifically dealing with soil and water quality	New practice to protect soil and water quality	When fodder harvesting, all of the following apply: 1. Recognised best practice methods must be used to: a.2. prevent increased soil erosion and instability resulting from the clearing; AND b.3. stabilise soil erosion and instability which has resulted from clearing; AND c.4. prevent increased sediment run-off entering a wetland, watercourse or drainage feature as a result of the clearing. 2.5. Clearing must not occur within 100 metres of a salinity expression area.	

Appendix E. Photographs illustrating recovery of mulga structure through time.

LWA 241 North, ~ 70km west of Bollon

April 2007 (14 years regrowth - pulled for fodder 1993)

May 2012 (19 years regrowth – pulled 1993; drought breaking rains 2008)

LWA 261 ~ 70 km north east of Cunnamulla

2008 West (5 years post fodder pushing; pulled 2002)

2013 West (10 years post fodder pushing; pulled 2002) Less rain during 2008 on this property than LWA 241

Appendix F. Regional Ecosystems covered by current and subsequent draft fodder codes

Note that table# 1 contains REs that can be harvested by any method and table# 2 REs that can only be harvested by selective methods

RE	Label	Table# in 2013 code	Table# in 2016 draft code	Table# in 2017 draft code
4.5.1	Acacia aneura ± Atalaya hemiglauca ± Grevillea striata low woodland on sand plains	1	1	1
4.5.2	Acacia aneura tall open shrubland on Quaternary sand sheets	1	1	1
4.5.3	Acacia aneura, Triodia brizoides or Triodia molesta tall open shrubland on Tertiary sand sheets	1	1	1
4.5.4	Archidendropsis basaltica and/or Acacia aneura ± Corymbia terminalis low open woodland on sand plains	1	1	1
5.5.1	Acacia aneura low woodland on Quaternary deposits	1	1	1
5.5.2	Acacia aneura ± Acacia sibirica ± Eremophila latrobei tall shrubland on Quaternary deposits	1	1	1
5.5.4	Acacia sibirica ± Acacia aneura ± Eucalyptus spp. open shrubland on Quaternary sediments	1	1	1
5.5.5	Acacia sibirica ± Eucalyptus spp. open shrubland on crests and tops of sandstone ranges		1	1
5.5.6	Archidendropsis basaltica and/or Acacia aneura ± Corymbia terminalis low open woodland on sand plains	1	1	1
5.6.4	Atalaya hemiglauca ± Acacia aneura ± Acacia spp. ± Corymbia terminalis tall shrubland on sand dunes	1	1	1
5.7.14	Acacia sibirica, Hakea eyreana ± Acacia aneura ± Eremophila freelingii open shrubland on sandstones	1	1	1
5.7.5	Acacia sibirica open shrubland with Triodia spp. ± Acacia aneura ± Acacia shirleyi open shrubland on crests and tops of ranges	1	1	1
6.3.21	Acacia aneura, A. excelsa and/or Geijera parviflora low woodland on low alluvial sand dunes	1	1	1
6.5.1	Acacia aneura, Eucalyptus populnea, E. melanophloia open forest on undulating lowlands	1	1	1
6.5.10	Acacia aneura ± Eucalyptus populnea ± Grevillea striata, A. excelsa, Hakea ivoryi low woodland on sand plains	1	1	1
6.5.11	Acacia aneura ± Eucalyptus populnea low woodland on sand plains	1	1	1
6.5.13	Acacia aneura ± Eucalyptus populnea ± E. melanophloia ± Brachychiton populneus low woodland on sand plains	1	1	1
6.5.14	Acacia aneura ± Eucalyptus populnea ± Eremophila gilesii subsp. gilesii tall open shrubland on Quaternary sediments	1	1	1
6.5.15	Acacia aneura, Eucalyptus populnea ± Eremophila sturtii tall open shrubland on sand plains	1	1	1
6.5.16	Acacia aneura groved with Corymbia terminalis or C. blakei tall open shrubland on Quaternary sediments	1	1	1

RE	Label	Table# in 2013 code	Table# in 2016 draft code	Table# in 2017 draft code
6.5.18	Acacia aneura ± Eucalyptus populnea ± E. melanophloia ± Eremophila mitchellii low open woodland on plains	1	1	1
6.5.6	Acacia aneura, Eucalyptus populnea low woodland on run-on plains	1	1	1
6.5.7	Acacia aneura, Eucalyptus populnea ± E. intertexta low woodland on run-on areas	1	1	1
6.5.8	Acacia aneura, Eucalyptus populnea ± Eremophila gilesii subsp. gilesii low woodland	1	1	1
6.5.9	Acacia aneura, Eucalyptus populnea ± E. melanophloia shrubby low woodland on Quaternary sediments	1	1	1
6.6.1	Atalaya hemiglauca ± Acacia aneura ± Acacia spp. ± Corymbia terminalis tall open shrubland on low dunes over alluvium	1	1	1
6.7.10	Acacia aneura ± Eucalyptus populnea ± Corymbia terminalis tall shrubland on residuals	1	1	1
6.7.11	Acacia aneura ± Eucalyptus cambageana ± E. thozetiana ± Eremophila latrobei tall shrubland on residuals	1	1	1
6.7.12	Acacia aneura ± Eucalyptus populnea ± E. melanophloia ± Eremophila gilesii subsp. gilesii tall shrubland on residuals	1	1	1
6.7.13	Acacia catenulata ± A. petraea tall shrubland on scarps and tops of ranges	1	2	2
6.7.17	Eriachne mucronata open grassland wooded with Acacia aneura and/or Corymbia terminalis on plains or flat tops of residuals	1	2	2
6.7.9	Acacia aneura ± A. clivicola ± Eremophila latrobei tall open shrubland on residuals	1	1	1
4.7.3	Archidendropsis basaltica, Acacia aneura low open woodland	2	2	
5.5.3	Acacia aneura, Acacia sibirica tall shrubland on Quaternary sand sheets	2	1	1
6.3.16	Callitris glaucophylla, Acacia excelsa, Geijera parviflora ± Acacia aneura woodland on alluvial dunes	2	2	2
6.3.18	Eucalyptus populnea ± Eremophila mitchellii ± Acacia aneura ± E. melanophloia woodland on flat alluvial plains	2	2	2
6.3.24	Eucalyptus coolabah or E. populnea woodland on alluvial plains	2		
6.5.17	Eucalyptus populnea ± E. melanophloia ± Callitris glaucophylla ± Acacia aneura woodland on sand plains	2	2	2
6.5.2	Eucalyptus populnea, Acacia aneura and/or E. melanophloia woodland on Quaternary sediments	2	2	2
6.5.3	Eucalyptus populnea, Acacia aneura ± Eremophila mitchellii woodland within A. aneura communities	2	2	2
6.5.5	Eucalyptus populnea ± E. intertexta ± Acacia aneura ± Callitris glaucophylla woodland on Quaternary sediments	2	2	
6.7.1	Acacia catenulata ± A. shirleyi ± Eucalyptus spp. open scrub on crests and slopes	2	2	2
6.7.14	Acacia clivicola ± Eucalyptus spp. open shrubland on crests and tops of residuals	2	2	2

RE	Label	Table# in 2013 code	Table# in 2016 draft code	Table# in 2017 draft code
6.7.15	Acacia brachystachya, A. aneura open shrubland on the lower slopes of residuals	2	2	2
6.7.16	Acacia clivicola, Eucalyptus exserta open shrubland on colluvials associated with residuals	2	2	2
6.7.6	Eucalyptus thozetiana ± Acacia aneura open woodland on scarps and slopes	2	2	2
11.3.17	Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains	2	2	
11.3.2	Eucalyptus populnea woodland on alluvial plains	2	2	
11.3.20	Forb and/or grassland ± scattered Atalaya hemiglauca, Flindersia maculosa, Acacia spp. on alluvial plains	2		
11.3.28	Eucalyptus coolabah ± Casuarina cristata open woodland on alluvial plains	2	2	
11.5.13	Eucalyptus populnea ± Acacia aneura ± E. melanophloia woodland on Cainozoic sand plains and/or remnant surfaces	2	2	2
11.7.1	Acacia harpophylla and/or Casuarina cristata and Eucalyptus thozetiana or E. microcarpa woodland on lower scarp slopes on Cainozoic lateritic duricrust	2		
11.7.2	Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	2	2	2
11.11.2	Acacia shirleyi or A. catenulata low open forest on old sedimentary rocks with varying degrees of metamorphism and folding	2	2	2