Quantifying Biodiversity in Carbon Forest Plantings

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Table of Contents

SUMMARY

Habitat Hectares (HH) is unsuitable because:

- It requires the assessor to be on site to conduct extensive field-based assessment
- It was created for remnant vegetation so is irrelevant for revegetation.
- It has a significant focus on understorey (shrub) components
- Recruitment component is too difficult to assess under a changing climate

Alternative options include:

- Queensland's BioCondition
- New South Wales' BioMetric
- DELWP's 'Native vegetation gain scoring' methodology

It is proposed that the gain scoring approach is used in a pilot assessment of several different aged sites using Greenfleet's planting data (number, type and spacing of planted species at establishment) and a survival rate assessment (after a given period of time) to determine whether our forests meet the minimum standard for revegetation under DELWP's guidelines.

1. INTRODUCTION

Greenfleet plants native forests using a diverse mix of indigenous tree species aimed at sequestering carbon to generate carbon offsets for Australia's voluntary and compliance carbon markets. With over 475 carbon forest planting sites (carbon forests), Greenfleet is one of the most experienced and recognised reforestation organisations in the country. These forests also provide significant co-benefits including soil stabilisation and erosion control, salinity reduction, groundwater quality improvement, wind-breaks and habitat links for native fauna. While these forests are diverse in species, overstorey tree species are the primary focus because they capture and store the most carbon and so understorey shrub and grass species that provide the structural complexity vital for ecosystem health and functionality are often omitted from planting. This report is focused on answering the following two key research questions in an attempt to measure the biodiversity levels in Greenfleet's forests so that future improvements can be made that benefit native flora and fauna:

1: Using Habitat Hectares (HH), can Greenfleet effectively quantify biodiversity across its estate?

2: If not HH, what other tools could Greenfleet use to measure biodiversity?

After HH is outlined and its limitations presented, several other methods and tools will be discussed. Overall, the report demonstrates that HH does not provide a suitable nor feasible approach for Greenfleet's purposes, and other state based analogous tools like QLD's BioCondition and NSW's BioMetric present similar limitations. Finally, DELWP's adapted HH approach for revegetation, 'gain scoring' is presented as a potential pilot approach for Greenfleet to use.

2. HABITAT HECTARES

The habitat hectares approach provides a method for measuring biodiversity and quantifying the quality of vegetation using 10 habitat characteristics in a given area including 7 site condition components; number of large trees, canopy cover, number of understorey lifeforms, weed cover, recruitment levels, organic litter cover, length of logs; and 3 landscape contextual components including patch size, proximity to remnant vegetation, and distance to the nearest core area (native vegetation >50ha) (McCarthy et al. 2004; Parkes, Newell & Cheal 2003). The approach was developed by David Parkes et al. (2003) and was adopted and refined by the *Department of Sustainability and Environment (DSE)* (DSE 2004; Parkes, Newell & Cheal 2003).

Habitat hectares was created to provide a quantifiable measure of biodiversity so that governments, natural resource managers, and developers could understand the impact of development and land use change and determine appropriate levels of mitigation or compensation (ecological offsets) (Maron et al. 2013; McCarthy et al. 2004).

HABITAT HECTARE METHODOLOGY: KEY STEPS

1. Identify the relevant *Bioregion* and EVC for the particular site
2. Initial broad site inspection/overview.
3. Estimate the number of Habitat Zones on the site.
4. Clarify the most appropriate EVC benchmark(s).
5. Habitat Ha scoring: components and landscape context
6. Provide a final Habitat score.

3. LIMITATIONS

There are a range of limitations with the habitat hectares (HH) approach identified in the DSE's guidelines and the broader literature. The first issue is that HH requires at least 5 of its 10 measurable components to be assessed on the ground (field-based) including measuring log lengths, assessing the prevalence and threat of invasive species (weeds), counting understorey lifeforms, organic litter cover and depth, and recruitment levels of native species. The assessment of these site-based components involves substantial labour resources that would come at a significant cost for Greenfleet if conducted across >475 revegetation sites. On the other hand, desktop based assessments using remote sensing could accurately assess other HH site components (canopy cover and number of large trees) and landscape components (patch size, proximity to remnant vegetation, and distance to the nearest core area). However, any habitat score derived from solely a desktop assessment (of these 5 components) would disregard half of the vegetation components which make up approximately 60% of the final habitat score (see table 1 below) (DSE 2004).

Table 1: Components and weightings of the habitat score (from the DSE 2004 manual).

	Component	Score
	Large Trees	**10**
	Tree Canopy Cover	**5**
'Site	Understorey	**25**
Condition'	Lack of weeds	**15**

	Recruitment	**10**
	Organic Litter	**5**
	Logs	**5**
'Landscape Context'	Patch Size *	**10**
	Neighbourhood *	**10**
	Distance to Core Area *	**5**
	Total	**100**

The second limitation is that HH was designed to quantify the biodiversity in remnant vegetation (un-touched by human activity) and subsequently focuses on assessing a large range of vegetation components that require decades and even centuries to naturally form, including logs, hollow trees, and healthy functioning canopy, sub-canopy and understorey layers (or structural complexity) (Munro et al. 2009). Therefore, in young and immature revegetation that lacks stratification, habitat quality assessments (using HH) will inevitably score far lower than in mature vegetation stands (Parkes, Newell & Cheal 2003). This is problematic for Greenfleet because its forests are on average only 10 years old (ranging from 0-20 years), so HH would always score poorly. Furthermore, researches have stated that even the best remnant vegetation stands rarely score higher than 80% (0.8) (Parkes, Newell & Cheal 2003), so Greenfleet would be very unlikely to score over 50% (of pre-1750 biodiversity levels) in <20-year-old sites. This could mean that claiming to plant 'biodiverse forests' would not be legitimate if those forests were not quantifiably 'biodiverse' according to the measurement tool (HH)[1].

Similarly, the most weighted component in HH is the understorey including; shrubs, herbs and graminoids, which make up 25% of the total habitat score (see table 1)

[1] This is further reflected in the literature, which outlines that while carbon markets can promote substantial carbon sequestration through reforestation and afforestation, additional payments are required to create any substantive biodiversity benefits (Bryan et al. 2014). Therefore, if Greenfleet wants to improve the biodiversity of its sites, including focusing on structural complexity with the establishment of understorey layers, greater investment will be required.

(DSE 2004). This provides an obstacle for Greenfleet's carbon plantings which are focused on carbon sequestration, with trees providing the primary carbon stock across all 475 sites and because forest biodiversity is tightly coupled with the structural complexity of its lifeforms (particularly understorey species), forests established primarily with overstorey species (trees >2m), subsequent biodiversity levels will be compromised (Munro et al. 2009). Therefore, using an approach like HH that recognises the importance of structural complexity in its scoring, means that the tool (in its current form) is inadequate for Greenfleet's purposes.

Another significant issue is related to the assessment of recruitment (natural seedling germination and establishment). When assessing episodic recruitment, disturbance regimes (outlined in HH and relevant EVCs) are drastically different under anthropogenic climate change (McCarthy et al. 2004; Pearse 2013). Increases in fire and flood frequency and severity mean that it is increasingly difficult to accurately predict disturbance regimes, which many native Australian species' recruitment are dependent on (Bryan et al. 2014; Parkes, Newell & Cheal 2003). Therefore, assessing the presence or absence of expected recruits (new growth) dependent on traditional disturbance regimes (unaffected by anthropogenic climate change) will be increasingly problematic (Bryan et al. 2014). In addition, the HH methodology, Victorian *Bioregions* and associated EVCs could be increasingly impacted by current and projected climate change (McCarthy et al. 2004), therefore, the accuracy of HH (dependent on EVCs) could be compromised as the relevance and effectiveness of historical ecological benchmarks diminishes under a changing climate (Harris et al. 2006).

4. IS ADAPTING HABITAT HECTARES FEASIBLE?

Greenfleet uses guidelines on carbon sequestration projections to predict the sequestration potentials of their forests 100 years into the future. Therefore, a similar method of biodiversity development could be implemented where the HH approach would assess the potential for biodiversity establishment over a 100-year time scale. However, the DSE guidelines specifically state for several of its measurable components that projected growth should be omitted and only current ecology, vegetation quality and present species should be quantified when using HH (DSE

2004). Nevertheless, DELWP have created an adapted version more relevant for young revegetation which is discussed in section 4.3 below.

Parkes et al. (2003) have indicated that variations of HH better adapted to the purposes of the assessor can be developed effectively. For example, riparian revegetation practitioners have used an approach based on HH to assess the success and biodiversity outcomes of their restoration projects. Therefore, similar adaptations of the HH approach provide Greenfleet with the precedent for developing a refined and tailored version to quantify the biodiversity of carbon and biodiverse plantings (see 4.3).

The primary indicator of biodiversity is large trees and canopy (crown cover) (Parkes, Newell & Cheal 2003), therefore, to save time and resources Greenfleet could narrow the HH assessment by eliminating components 4-7 (weeds – logs) and instead only assess trees, canopy and understorey. This could be done without compromising the approach by standardising the score to reflect the fewer components being assessed. The DSE guidelines state that HH can be adapted and standardised in the case where particular components (that the EVC provided) are absent, which would be expected in Greenfleet's young forests (DSE 2004). However, Dr. Sabine Kasel, Senior Research Fellow at the University of Melbourne's School of Ecosystem and Forest Sciences, stated[2] that the assessment of weeds (and their relative threat levels) in a revegetation or restoration area provides an important indicator for the ecosystem's health and biodiversity value. Similarly, Dr. Kasel mentioned that logs provide a structural component that can create significant biodiversity benefits. Therefore, the omission of these components may be undesirable if Greenfleet wants to demonstrate the biodiversity value of their sites effectively. Alternatively, the addition of logs and a focus on removal of weeds could significantly increase the attributable biodiversity scores across Greenfleet's estate.

[2] Dr. S Kasel provided this statement during a meeting about measuring biodiversity and Habitat Hectares that I had with her in September 2017

5. ALTERNATIVES

There are a range of alternative tools and methodologies for quantifying biodiversity including several analogous to HH, however, it should be noted that these present similar limitations as the Victorian method. This section will outline two other state based tools and then outline some alternative methodologies that could provide more relevant approaches for assessing ecological outcomes from revegetation and reforestation projects.

5.1 Queensland's 'Biocondition'

BioCondition is the assessment tool that the Queensland state government's Department of Environment uses to measure the functionality and health of terrestrial biodiversity in a given ecosystem. The approach is quite similar to Victoria's HH and is a site-based, quantitative and repeatable assessment procedure that provides a score or biodiversity condition framework rating between 1-4 (functional through to dysfunctional vegetation). The condition refers to the vegetation attributes of a given site compared with the attributes provided by the regional ecological (RE) classification benchmark (Eyre et al. 2015). One key difference between BioCondition and HH is that BioCondition includes a fauna assessment component in its approach, whereas HH is limited to flora assessment.

5.2 New South Wales' 'Biometric'

Biometric is the NSW's state government Department of Environment (DECCW)'s assessment tool used to measure the effects of clearing remnant native vegetation and protected regrowth on threatened species, land and soil, salinity, and water quality. In conjunction with GIS mapping tools, BioMetric conducts a complex quantification of vegetation quality and associated biodiversity values (DECCW 2011). Its primary purpose is to "assess losses of biodiversity from proposed [land] clearing, including ecological thinning, and calculate gains in biodiversity from proposed offsets" (DECCW 2011). However, the DECCW states that BioMetric is not designed to assess "private native forestry, and clearing for routine agricultural management activities or of regrowth" (DECCW 2011), again highlighting such tools as inadequate for quantifying biodiversity levels in revegetation sites.

5.3 Native vegetation gain scoring

Vegetation gain is measured by predicting the overall improvement of a site using biodiversity equivalence units which enables restoration practitioners to assess the losses and gains of land use change and associated revegetation in order to ensure additionality and no net loss objectives are met (DEPI 2013). DEWLP's *'native vegetation gain scoring manual'* states that:

> *"Site gain refers to the improvement in condition, security and extent of native vegetation that is predicted to occur at the site level as a result of active management and increased protection…measured in Habitat Hectares" (DEPI 2013).*

This poses a problem for Greenfleet, as ongoing management would need to be conducted for any predicted biodiversity gains to be successfully met in the long term. More specifically, increasing protection of a revegetation site would not be enough to ensure long term ecological benefits and rather active management of the ecosystem would be a co-requisite for ongoing biodiversity improvements to be achieved. Furthermore, the approach still involves the use of HH, which again presents several limitations as previously discussed.

The site gain methodology is built on the former DEPI's revegetation and supplementary planting standard that outlines a 10-year survival target and minimum diversity relevant to vegetation types identified with the appropriate EVC benchmark (DEPI 2013). The standard aligns with Greenfleet's purposes because it does not require herbs, prostate shrubs, or medium/small grasses to be planted and subsequently assessed. The standard outlines specific survival target numbers for overstorey species (trees/plants) per hectare as follows:

- 50 plants/ha for woodlands
- 100 plants/ha for dry forests
- 150 plants/ha for riverine/lowland/foothill forests
- 200 plants/ha for damp/wet forests

The required target number of understorey plants/ha for each habitat component are calculated according to Table 2 below. The benchmark per cent cover for each understorey habitat component is used (DEWLP 2017).

Table 2: 10-year survival target number of plants for understorey habitat components (DELWP 2017).

Understorey habitat component	Target no. of plants / ha (for each 5% cover in EVC benchmark)	Notes
Understorey tree > 5 m tall (T)	50 plants	Assume 10 plants / ha where benchmark cover is 1%
Medium shrub 1-5 m tall (MS)	200 plants	Assume 40 plants / ha where benchmark cover is 1%
Small shrub < 1 m tall (SS)	500 plants	Assume 100 plants / ha where benchmark cover is 1%
Large tufted graminoid (LTG) (grasses and grass-like tussocks > 1 m tall)	500 plants	Apply only where benchmark cover for LTG habitat component is 10% or greater

The manual also provides the minimum standards for survival target diversity calculated using the table below. This calculation categorizes the site into either a minimum standard or higher standard biodiversity score and provides Greenfleet with a more appropriate and relevant approach to quantifying ecological health and functionality than the conventional HH approach is capable of. However, this may still provide a problem for Greenfleet as the minimum standard for target diversity requires at least 6 understorey component species to survive after 10 years, which would prove impossible when less than 6 of these component species were planted in the first place. This again highlights the need for establishing more understorey species, although rather than small-medium shrubs and grasses understorey trees >5 metres tall that would include acacias could feasibly make this minimum requirement with relative ease.

Table 3: 10-year survival target diversity of plants for overstorey and understorey habitat components (DELWP 2017).

Habitat component	Target diversity minimum standard	Target diversity higher standard
Overstorey (canopy trees)	At least 1 species	n/a
Understorey tree > 5 m tall (T)	At least 6 species	At least 10 species
Medium shrub 1-5 m tall (MS)		
Small shrub < 1 m tall (SS)		
Large tufted graminoid (LTG) (grasses and grass-like tussocks > 1 m tall)		

6. RECCOMENDATIONS AND CONCLUSION

Habitat hectares provides a comprehensive tool for Greenfleet to measure the biodiversity in its 475+ revegetation sites. However, the approach was designed by Parkes et al. in 2003 as a way to assess the quality of remnant vegetation in comparison to an appropriate EVC benchmark or pre-1750 biodiversity level. Furthermore, HH requires significant ground-truthing to be effectively implemented which would require far more resources (time and financial) to be invested in Greenfleet's operations (DSE 2004). Subsequently, HH is not suited to assessing the quality (health, extent, diversity and functionality) of relatively young revegetation and even less so for young carbon forests (trees planted primarily for the sequestration of carbon) (Bryan et al. 2014; Munro et al. 2009; Pearse 2013). Other state based biodiversity measurement tools like QLD's BioConditon and NSW's BioMetric offer alternative methodologies for quantifying biodiversity levels across Greenfleet's estate, however, like HH these tools have a range of similar limitations (DECCW 2011; Eyre 2015).

Although the HH approach is unsuitable for Greenfleet's purposes, the Victorian Government has developed an adaptation of the methodology based on Victoria's EVC benchmarks for the assessment of revegetation and their projected gains in biodiversity (DEPI 2013; DELWP 2017). The '*Native vegetation gain scoring manual'* provides an adapted version of HH that is more relevant and cost effective. However, even this approach still requires ground-truthing to assess the survival rate after planting and so could still have significant associated costs. Nevertheless, instead of generating a low and therefore counterproductive numerical score as HH would do for young forests, this adapted approach would provide a minimum or higher standard categorisation that Greenfleet would be able to market, without being misleading.

Greenfleet, could look at assessing a random sample of its mid-old sites (10-20 years) to assess whether their forests are meeting the minimum revegetation gain requirements under gain scoring guidelines with results being extrapolated across its estate. This random sample could select sites in different geographic, climatic and vegetation type locations to get the most comprehensive and representative results. Alternatively, the assessment could look at new sites and then set up a longer-term monitoring of plant survivorship and/or it could use pre-existing data that Greenfleet has to assess if the minimum targets have been met on older sites. Initially, an assessment trial could be conducted to see if the approach was in fact suitable and feasible with limited resources (and possibly through desktop-based analysis). If this trial was successful the larger scale assessment of randomly selected sites could be conducted. If, however the approach was deemed unsuitable other approaches used in Australia and globally would need to be investigated.

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