VegCAT

Vegetation Condition Assessment Tool Guidelines

A rapid and cost-effective method to detect structural and compositional changes in the condition of native vegetation communities as a result of condition improvement projects.

Developed to maximise alignment with the Queensland Herbarium's BioCondition method.

NOTE: this method does not provide data on changes in biodiversity.

Prepared by Andrew Burrows and Penny Scott, through the Queensland Government's Natural Resources and Investment Program (NRIP – 2018-2022)
With technical advice from the Queensland Herbarium and input from Regional NRM Bodies.

THIS IS A USER ACCEPTANCE TESTING PHASE GUIDLINE:
Scheduled for finalisation and broad distribution by December 2022

Table of Contents

Introduction 2

How to use this guideline 3

Section 1 – Assessment units, plot selection, number of plots and plot layout. 4

Defining the different assessment units within the project area 5

VegCAT Plot Placement 8

Number of Plots 9

When to Assess 9

Plot Layout 10

Equipment needed 11

Photo points 12

VegCAT Attributes 13

Section 2 – Methodology to measure each attribute. 14

Attribute 1 –Canopy and sub-canopy cover (measured together). 14

Attribute 2 – Native shrub cover 16

Attribute 3 – Ground cover 16

Attribute 4 – Recruitment of woody canopy species 17

Attribute 5 – Non-native plant cover 20

Attribute 6 – Animal soil disturbance 22

Attribute 7 –Revegetation survival 24

Attribute 8 – Dominant canopy height 26

Step by step guide to laying out plot and measuring attributes. 27

Example Scoring Sheet 0

Section 3: Scoring VegCAT 0

VegCAT Scoring Methodology 0

References 2

Appendix 1 - Condition Monitoring Plan (template) 3

Appendix 2 – Optional Attributes 6

Appendix 3 – Method to determine Vegetation Strata 7

Appendix 4 – Method to measure tree height 9

Introduction

The Vegetation Condition Assessment Tool (VegCAT) has been designed as a rapid approach to measuring the change in vegetation structural condition resulting from investment projects such as the Queensland Government's Natural Resource Management Programs. Its core purpose is to track the short-term results of this investment during a project's lifetime, providing evidence that the condition of the target vegetation is progressing on a general trajectory towards 'healthy'. 'Healthy' is determined in advance drawing on whatever scientific resources are available, and wherever possible and available, the Queensland Herbarium's Regional Ecosystem Benchmarks or Descriptions.

VegCAT aligns to the greatest extent possible with the Queensland Herbarium's BioCondition methodology, including a number of attributes from BioCondition as well as some aspects of the plot layout. It does not replace BioCondition, and is not designed to provide an assessment of the biodiversity value of the vegetation. It focuses on the structural and compositional attributes in vegetation that are relatively easy to assess, are anticipated to change as a result of the project and can operate as proxy indicators of increasing 'health'. The methodology for the more comprehensive BioCondition is available at https://www.qld.gov.au/data/assets/pdf_file/0029/68726/biocondition-assessment-manual.pdf.

The focus of VegCAT is to enable a rapid assessment of condition which is sufficiently sensitive to shorter-term changes in vegetation condition as a result of project interventions, sufficiently robust (while acknowledging that this is not a scientific endeavour), but also cost effective and can be undertaken by field staff with some technical knowledge about the site.

A key feature of this method is the combination of two approaches to scoring the attributes of a VegCAT plot. These two forms of attribute scoring are described below:

- ***Direct comparison with 'healthy' benchmarks:*** For more straightforward attributes, measurements from the plots are compared with what is considered 'healthy' for that attribute (either based on an official benchmark figure or the best available scientific documentation and expert advice). The attribute is assigned a score in line with the BioCondition methodology. Attributes which are scored according to this direct comparison method are canopy height, canopy cover, shrub cover, native perennial grass cover and organic litter.
- ***Evidence-based judgement rating:*** For a selection of less straightforward attributes, the rating approach enables the field technicians to consider a range of factors in determining the condition of the vegetation in relation to these attributes, while at the same time requiring the field technicians to collect empirical, numerical data to back up this judgement, combined with photographic evidence. Based on the data collected in the subplots, and the observations in the plot as a whole, the field team rate the attribute condition, using a set of statements as a guide. Attributes scored using this evidence-based rating system include weed threats and natural recruitment. Both of these attributes are challenging to assess effectively against a numerical benchmark, as there are so many factors to consider (e.g. the species of the weed, whether or not it is a transformer weed, its level of maturity). While the rating of these attributes is more subjective, the ability of field technicians to take a range of factors into consideration is anticipated to result in a score which more accurately reflects the situation.

It is expected that once staff are familiar with the methodology, it will take a maximum of 1 hour to assess each plot, subject to the complexity of the plot and the nature of the vegetation itself. However, it is highly recommended that if money and expertise permits, a BioCondition plot is also established as a baseline, with the VegCAT method nested within the 50-metre subplot. In this way, a full understanding of the condition of the vegetation is established from the onset, which may assist to inform management, but will also open up longer-term biodiversity monitoring opportunities.

Although this methodology stands alone and includes a hard copy field data collection form, it is accompanied by a **Survey 123 VegCAT App**, which supports the digital collection of data in the field, automatically generating a score for the plot and auto-populating a customised geo-database that is housed within the user-organisation's ARCGIS online account. In relation to the use of VegCAT by Regional NRM Bodies, this geo-database will be identical for all regions, enabling the results to be analysed for a State-wide assessment of progress towards Queensland Government investment in vegetation condition outcomes.

The VegCAT methodology also requires the development of a '**Condition Monitoring Plan**' ***BEFORE*** gathering monitoring data. This key foundational document has two purposes:

- ***It specifies 'healthy' for that vegetation type:*** This document describes the proposed outcomes of the project and in particular specifies what 'healthy' is for each attribute. Drawing on whatever evidence (e.g. RE benchmarks, descriptions or other literature in relation to that vegetation type) and/or expert opinion is available, it specifies the condition for each of the attributes towards which the project is aiming, and provides the basis for comparison with what is seen in the field. For the Direct Comparison attributes, it is this comparison that determines the score. For the ratings attributes, it is this description that is considered when assigning a condition rating value.
- ***It describes and justifies the monitoring approach:*** This document records the rationale behind the monitoring approach for this particular project or project site (e.g. assessment unit delineation and number and location of plots). It is a key document to justify the monitoring approach for the project/project site, as well as to ensure that future staff that may not have been involved in the design of the monitoring scheme, understand the logic that underpins it.

See Appendix 1 for a **Condition Monitoring Plan** template. This template is not mandatory and can be modified to suit the requirements of the user organisation.

How to use this guideline

This guideline has a number of sections and should provide all the information required to undertake vegetation condition monitoring. It is divided into 3 sections.

> ***Section 1*** provides guidance on how to define *assessment units*, select the *plot locations*, and the *number of plots* required. This is essential for deciding on the monitoring approach, and justifying this within the Condition Monitoring Plan. It also covers how to *layout* the plot
>
> ***Section 2*** provides details on each of the attributes and how they should be assessed and, where relevant rated.
>
> ***Section 3*** provides a step-by-step guide to setting out the plot and collecting the data in the field, as well as a paper-based field collection sheet that is aligned with the VegCAT App. It is recommended that even if the App is being used in the field for data collection, a copy of the paper-based data collection form be taken into the field in case of issues with devices etc. Information from the paper form can be transferred into the database through the App back at the office. Uploading relevant photos into the record will be important at this stage, as well as ensuring the location of the Survey123 record is accurate.

Appendices provide details on the **Condition Monitoring Plan** and guidance on how to measure vegetation height, and optional guidance on additional attributes that can be measured.

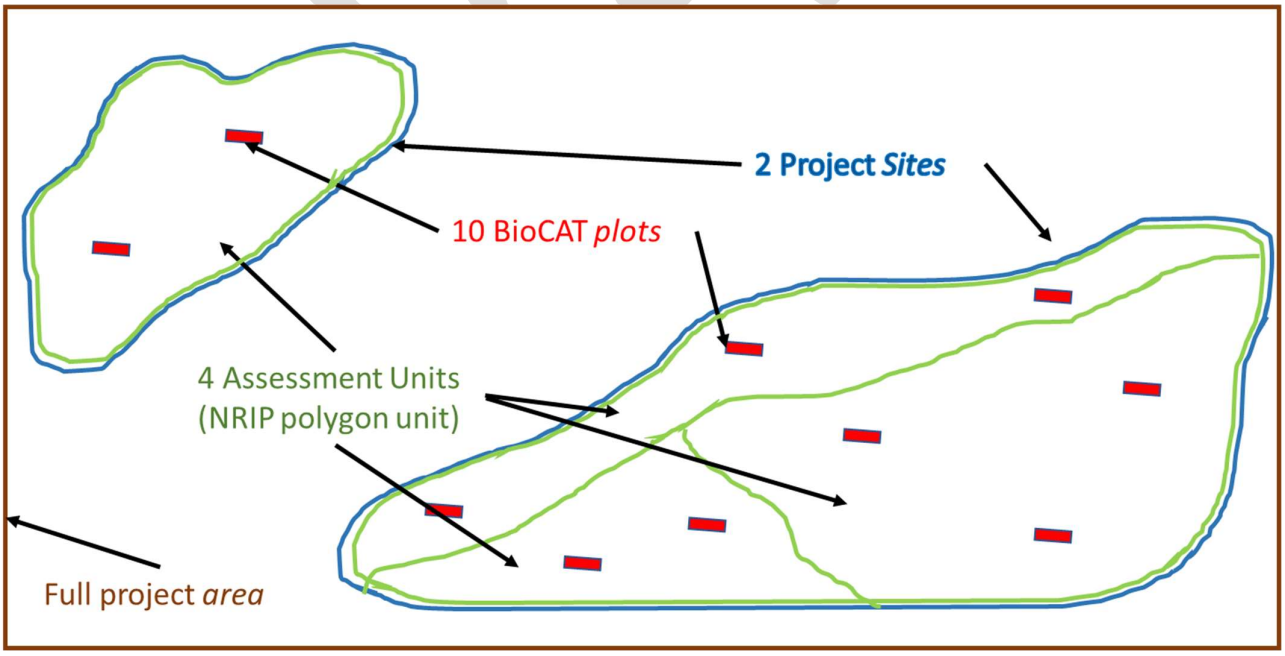
It is important to note that this guideline specifies the ***minimum requirements*** for the collection of vegetation condition data for the Queensland Government NRM investment programs. Should people want to undertake the full BioCondition methodology, the plots described in this guideline can be embedded into the larger BioCondition plot, and any data collected from BioCondition can be used to inform the scoring and ratings in VegCAT. If doing this, the attributes listed in this guideline must still be collected according to the VegCAT methods within the 50x10m plot, to ensure State-wide consistency.

Section 1 – Assessment units, plot selection, number of plots and plot layout.

To ensure that the methodology applied to undertaking vegetation condition assessments through VegCAT is both **consistent** AND **credible**, guidelines have been prepared on what to take into consideration when deciding where to locate plots, and how many plots are sufficient. It is recognised that all projects are different – and even within one project, there may be a number of project sites that are different. For this reason, this section provides ***guidelines on what to take into consideration*** when designing your monitoring – but allows for flexibility to tailor your method according to your project context. In other words, it does not dictate hard and fast rules about how many plots need to be established in a project area of a certain size. However, with this flexibility comes the responsibility of regions to clearly articulate the reasoning behind the decisions you have made. The **Condition Monitoring Plan** is critical in providing justification and clarity for how you have applied these guidelines to your monitoring system.

For clarity, the following terms are used in this guideline (and illustrated below):

- The total **project area:** this is the full extent of the project and could cover more than one geographic location
- **Project sites**: discrete spatial units within a Project Area. This could be the same as the Project Area if the project has only 1 geographic location.
- **Assessment units**: within one discrete project site, there may be multiple assessment units which are delineated due to differences in the vegetation as described below. It is the area of these assessment units that will be used when extrapolating the data from the VegCAT plot/s. For the purposes of the State-wide Indicators Framework, each assessment unit needs to be represented by an individual polygon. The average scores of the plots within an assessment unit will be multiplied by the area of this assessment unit for the purposes of reporting condition change.
- **Plots (and sub-plots):** these are the 50x10 metre areas that are subject to assessment – there may be one or more plots in each assessment unit – these plots should be permanent and be re-assessed at pre-determined times during the life of the project.



Defining the different assessment units within the project area

Each **project area and/or site** will need to be categorised into different ***assessment units*** to ensure that plot data is captures the variation that exists within a project area and/or site. This is an important component of the monitoring design and will assist in arguing the credibility of the resulting data.

Defining the number of assessment units for your project area/site will be based on three factors:

1) The **type of vegetation** community (regional ecosystem or broad vegetation group);
2) The **state/condition** of the vegetation community (e.g. regrowth vs remnant; heavily damaged vs in reasonable condition); and
3) The **management intent** of the proposed area (e.g. One area may be subject to herbicide control, while another area may be subject to fire control. Due to the two different management approaches, each would be a unique assessment unit).

If there is no variation in all of the above for your project area and your project area only contains one spatially explicit site, then you will only have one assessment unit. However, this is often not the case, particularly with larger projects.

Accounting for variation in the type and condition of vegetation as well as management intent through delineating different assessment units allows each unit to be tracked individually over the course of the 4-year project. It also ensures that when extrapolating to the whole of the project area, the samples adequately reflect any variation. The results from plots in one assessment area will be combined and extrapolated to the hectares of that assessment area only, giving a more accurate overall assessment of the project's impact.

An example may be where some projects have a combination of riparian ecosystems and dry sclerophyll ecosystems. Each ecosystem or vegetation community will then be categorised into unique assessment units. Due to the fact that the vegetation types are different, and you may well be applying different management interventions, it is likely that the vegetation response from the project will be different. Having clearly delineated assessment units – represented as individual polygons in the project geo-database, will enable any such variation to be tracked and accounted for in reporting.

Another example could be where the vegetation community or regional ecosystem is the same, but they are in very different condition – one area may have experienced a severe fire and the other not. If the project area involves mature communities and cleared areas requiring revegetation, the change in height of the vegetation will be more dramatic in the revegetation area, and so that needs to have its own unique assessment unit so that it can be tracked accordingly. If one area has much higher infestations of a target weed species, and management intervention for this weed is heavily focused there, you would expect a more significant change in condition to be recorded in these areas.

Delineating assessment units in this way also provides flexibility for your own regional analysis of the VegCAT data. You may be interested in the response of the vegetation to particular interventions in one assessment unit. By having these pre-defined, you can tailor your analysis of the plot data to provide information about the results in specific areas of your project with no additional calculations or analysis required.

Defining when a vegetation condition triggers a unique assessment unit will be at the project team's discretion and linked to the purpose of the project. The reasoning will then be recorded in the **Condition Monitoring Plan** (see Appendix 1), to ensure clarity and credibility around that decision.

The following three steps provide the process to delineate assessment units.

Step 1 - Define the type of ecosystem or vegetation community

The purpose of this step is to identify the different types of vegetation community, AND to consider how the difference between them is likely to result in a different response to project interventions.

Use the available mapping (regional ecosystem mapping, broad vegetation group mapping) to identify the vegetation communities within the project area. Where possible, ground truth the available mapping to confirm that it is accurate. You might also be able to validate the mapping using high quality aerial photographs of the area.

Produce a map of the project area that shows the different vegetation communities using the available mapping. In the below example, the project area (outlined in orange) is mapped into 2 different regional ecosystems. It has been decided that these 2 REs are different enough in their structure and in the change we expect to see from our project works, that they should be considered separate assessment units. You may also choose to use the Broad Vegetation Groups as the basis for delineation, particularly if there is little structural difference between neighbouring REs.

Figure 1: The project area mapped into two vegetation communities using the regional ecosystem mapping. Other mapping such as broad vegetation groups may also be suitable.

Step 2 – Define assessment units based on the condition of the vegetation community

The purpose of this step is to assess the extent to which *within* a vegetation community, there is a significant difference in the condition of the vegetation that would result in a different response to project interventions. This assessment can be based on the aerial imagery combined with local knowledge of the site where possible.

Where the vegetation community is the same, but it is in a markedly different condition, such as degraded through weed infestations, or in regrowth phase, they will need to be treated as a different assessment units even if they are

the same vegetation community. Also, if your project site contains an area that is largely cleared and will be revegetated, but the site also contains an area where there is remnant or regrowth and you may only do some spot weed management, these will need to be delineated as different assessment units.

In the below example, the 2 regional ecosystems have each been split based on being in different condition. Overall the area has 4 distinct assessment units with the reasoning behind this decision having been captured in the **Condition Monitoring Plan** (see Appendix 1). Plots will be established in each of these assessment units in order to capture the variation, and account for this in the analysis.

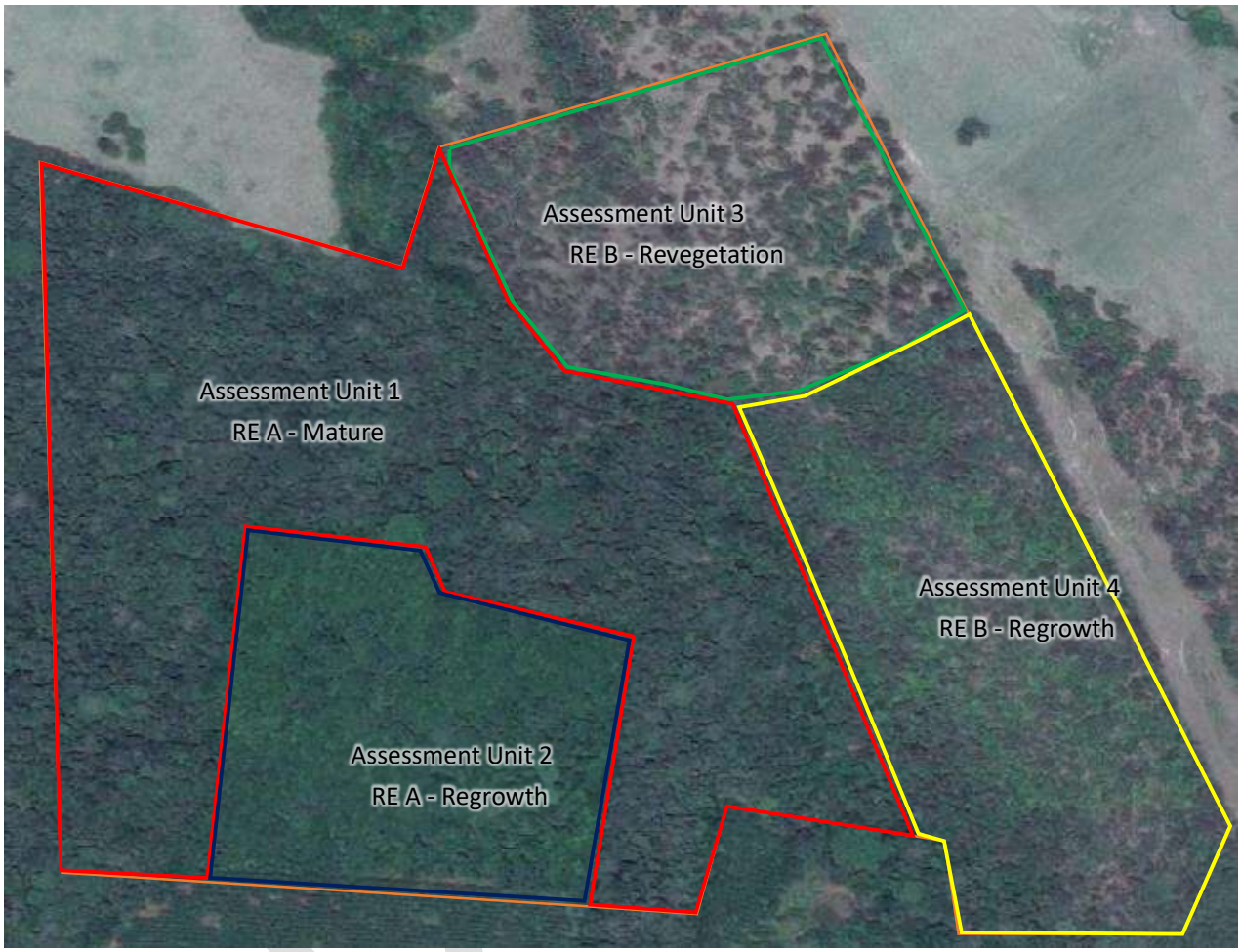


Figure 2: The project area delineated into 4 assessment units based on different regional ecosystems AND differences in vegetation condition.

Step 3 - Further define assessment units based on differences in management intervention

In situations where markedly different management approaches or interventions are being implemented to the same type of vegetation in pretty much the same condition, unique assessment units need to be created. An example may be an area of open woodland that is subject to weed infestation. One half of the area is to be treated through burning, while another area is to be treated through chemical control. As the responses of the vegetation is likely to be different, they need to be monitored separately as unique assessment units. As with all assessment unit delineation, the reasoning will be documented in the **Condition Monitoring Plan**. As mentioned above, this may also provide important empirical data on the relative effectiveness of different management approaches over time.

VegCAT Plot Placement

Every Assessment unit must have *at least 1 VegCAT* ***plot.*** The plot location should be selected to ensure maximum representativeness in each of the assessment units, but also wherever possible, should be selected randomly. If feasible, plots should ideally be approximately 50m from any disturbance, such as roads, dams (Eyre et al. 2015). Where multiple plots are required for an assessment unit, they should ideally be at placed at certain intervals based on a systematic or randomised method. The rationale for the selection of plot location should be provided in the **Condition Monitoring Plan**.

Choosing VegCAT plot location within the assessment unit could occur through a range of ways. For example:

1) Randomly placing the VegCAT plots along lines that run through the assessment unit. This method is good for linear sites. This method can be repeated across other lines if more VegCAT plots are required.

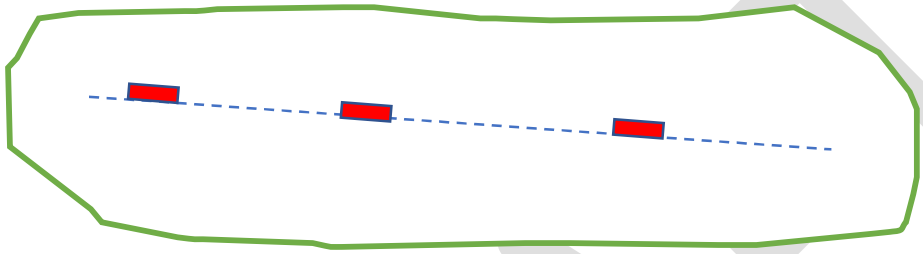


Figure 3: Within the assessment unit (green outline), run a line through the site, and place the VegCAT plots randomly – or systematically – along the line. Replicate this line through the assessment unit if more VegCAT plots are required.

= VegCAT plot

2) Radiating the VegCAT plots from a central point in the assessment unit. This could occur at different lengths and angles based on the size of the assessment unit.

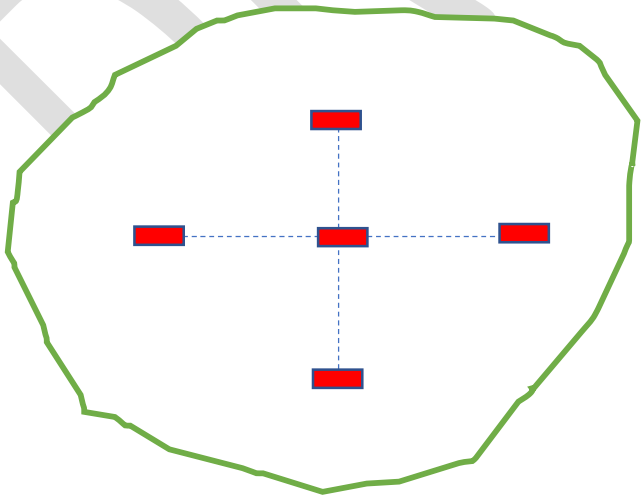


Figure 4: Within the assessment unit (green outline), randomly choose a central plot and have radiating arms along which the remaining plots are positioned. This could be at different angles and lengths depending on the number of VegCAT plots required.

= VegCAT plot

Number of Plots

The number of plots to be established and assessed should be based on the size of the assessment unit, the diversity in vegetation type and condition and the available resources. The more plots, the more representative and accurate the data will be, providing greater confidence levels in terms of communicating the impacts of the project. BioCondition recommends that the following plots are implemented as a minimum. However, VegCAT allows for flexibility and the final decisions on the number of plots will consider a range of project/site-specific factors. The **Condition Monitoring Plan** allows for these site-specific considerations, and is the place where final decisions should be documented and justified, particularly if they differ significantly from the below recommendations.

Assessment Unit Area	Number of VegCAT Plots
Less than 1 ha	1
1-5	2-3
5 – 60ha	3-5
60-500 ha	6
>500 ha	7+

Table 1: Number of plots required based on each assessment unit size

When to Assess

The assessment timing and frequency needs to be determined based on when it is practical and most relevant according to your project objectives, and should be followed consistently in the following years. The proposed assessment times and frequency need to be explained in the **Condition Monitoring Plan**.

It is important that assessment of each plot occurs at the same time each year. It would not be an accurate comparison to compare one set of data collected at the end of the dry season, and the following year's data from the middle of the wet season. It is recommended that plots are assessed annually. This is not only helpful in terms of providing data for the reporting, but also to provide data for project management and adaptation. The following is a guide from BioCondition which can be applied if relevant for the project context and objectives.

Recommendations of Assessment Timing from BioCondition.

Eyre et al. (2015) recommends that at a minimum, assessment should occur ideally at the end of the summer rainfall growing season – approximately late March to late May. Furthermore assessment:

- north of the Tropic of Capricorn should generally be conducted after the wet season between March May; and
- South of the Tropic of Capricorn should occur in May or June.

This assessment timing supports the ability to identify the many species that are more likely to be visible following the wet season.

.

Plot Layout

The VegCAT plot is 50x10m, and is centred on 50m transect. A 10x10m subplot will be located at the start, middle and end of the transect, and within each of these sub-plots there is a 1x1m subplot. The full 50x 10m plot is used to assess the height of the vegetation.

At a minimum the plot can be marked out using 3 star pickets (or equivalent permanent plot markers). One at the 0m, one at 10m for the photo reference point and one at the end 50m. The 10x10m plots can be marked out by 2x10m length ropes that can be placed perpendicular to the transect. The 1x1m plots can be marked out using tape or with a pre-made quadrat. Alternatively, two people can straddle the transect tape, forming a 1X1 metre square with their legs.

The 10X10 metre sub-plots can also be permanently marked out with star pickets, placing them at the corners. This can make follow-up assessments faster. A diagram of the plot layout is shown below.

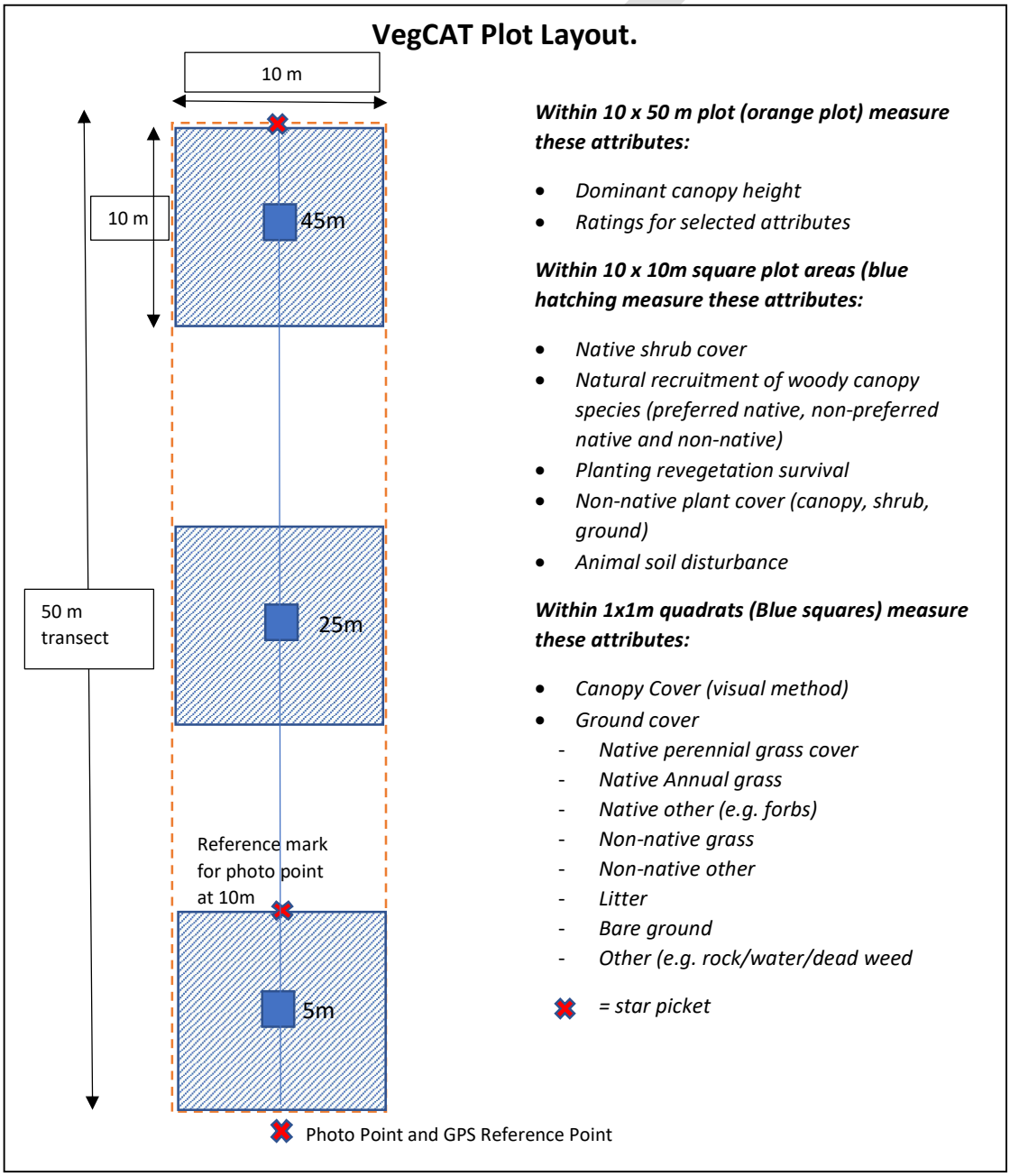


Figure 5: VegCAT Plot layout

Equipment needed

The following equipment is required for each VegCAT plot layout.

- 50m transect tape
- 2 x 10m length of rope with mark at the 5m
- 1 x 1m quadrat for measuring ground cover (can use electrical pipe as an easy quadrat that can be dismantled as required). Alternatively, the 1x1 metre quadrat can also be assessed using the tape with legs straddling the tape, approximately 1 metre apart.
- Phone with VegCAT Survey 123 App ***already downloaded***
- 3 star pickets as a minimum or equivalent stakes for 0, 10m and 50m points along transect. If the plot is to be marked out permanently – an additional 12 star pickets would be required.
- Device for installing star pickets or equivalent (hammer or star picket driver)
- Spray paint, safety caps or flagging tape to mark the star pickets for safety.
- Diameter tape for measure size of trees (optional if doing full BioCondition)
- Plant Identification books (optional)
- **Condition Monitoring Plan** (printed and laminated)
- Paper-based form as a back up
- **THIS GUIDE**

Figure 6: Example of minimal equipment required for the VegCAT plot set up.

Photo points

The key part of photo point monitoring is that the same photo is taken at the same spot each monitoring period so that it can be compared to previous years and show the change.

As a minimum photo points are to be taken

1. From 0m on transect focusing on the 10m star picket
2. From the 50m transect looking back down the tape.

Below is a guide to using the star picket for

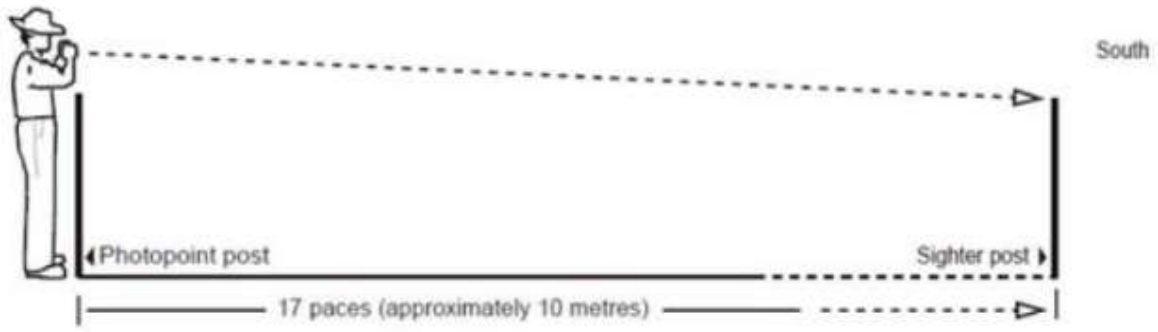


Figure 7: Example of photo monitoring point looking at the 10m star picket.

Additional photos will be recorded as part of the VegCAT App including crown cover and ground cover, and left and right photos at points 5, 25 and 45m.

VegCAT Attributes

Below is a summary table for the attributes to be collected as well as an overview of the alignment with the full BioCondition methodology. The following section contains detailed descriptions of these attributes.

Table 2: Summary of attributes, technique to measure, how it is aligned to BioCondition.

Plot Area	Attribute	Technique to measure	Scoring Approach	Alignment with BioCondition
1 x 1m subplot at points 5, 25, 45.	Native canopy cover/projected foliage cover	Looking up, and referring to a photograph taken of the canopy from chest height, estimate the % of dark versus light.	Data entered based on 10% band (0-10%, 11-20%, 21-30%..). Score is comparison of average % cover compared with benchmark.	In BioCondition, canopy cover is determined using an alternative method. Comparison of the 2 methods in 25 VegCAT plots generated the same score.
	Ground cover assessing: - Native perennial grass - Native annual grass - Native other (e.g. forbs) - Non-native grass - Non-native other - Litter - Bare ground Other (rock, water)	Estimate proportions of each category and enter so that it adds to 100%	Data entered as actual figures that add up to 100%. Example *-Native perennial grass – 40%* *-Native Annual grass -10%* *-Non-native other – 25%* *-Litter – 25%* Score compares extent of litter with benchmark	Attribute aligns with BioCondition, however it is collected 5 times in BioCondition where as VegCAT only collects it 3 times.
10 x 10m subplot at points 5, 25, 45	Native shrub cover	10x10m plot estimate and enter as 10% band	Data entered based on 10% band (0-10%, 11-20%, 21-30%..). Score is comparison of average % cover compared with benchmark.	Attribute aligns with BioCondition but is assessed in 3 sub-plots rather than along 100 m transect.
	Recruitment of woody canopy species split into a) Preferred native species b) Non-preferred native species c) Non-native species	Count number within the plot. *So if there were 10 of species A, 6 of species B and 4 of species C – the count would be 20.*	Three pieces of data a) Preferred native canopy spp. b) Non-preferred native canopy spp. c) Non-native canopy species Score is according to field officer rating, taking into account range of natural recruitment factors.	BioCondition only requires the number of canopy species present as recruits to be recorded. VegCAT enables a number of factors to be taken into consideration.
	Non-native plant cover (canopy and sub canopy), assessed individually at 3 levels; canopy, shrub and ground.	10x10m plot estimate and enter as 10% band (0-10%, 11-20%, 21-30%..). There are 3 fields for each layer.	Data entered based on 10% band . Score is according to field officer rating of the threat from non-native plan species, taking into account range of non-native plant factors (cover, species, growth phase).	This attribute has more detail than BioCondition as it collects data for different strata/layers and takes into account other factors in assigning a threat rating. This is a key area of focus for many projects.
	Survival of planting revegetation	Estimate survival of planting through 10% bands or count dead vs living planted and enter as a 10% band	Scores entered based on 10% band (0-10%, 11-20%, 21-30%..). Score is according to field officer rating, taking into account revegetation status within the plot.	Not part of BioCondition. *This rating does not affect overall result but can be used for project management and reporting.*
	Animal Soil Disturbance	10x10m plot estimate and enter as 10% band Enter rating to summarise animal disturbance status within the plot	Data entered based on 10% band (0-10%, 11-20%, 21-30%..). Score is according to field officer rating taking into account extent and nature of soil disturbance in plot.	Not part of BioCondition. *This rating does not affect overall result but can be used for project management and reporting.*
10 x 50 m plot area	Dominant Canopy Height	1) If mature – use clinometer method. 2) If regeneration use actual measurement.	Actual Figure (eg. Tree height 22m). Score is comparison with benchmark.	Aligns with BioCondition

Section 2 – Methodology to measure each attribute.

This section outlines the method to collect the data for each plot, including a detailed description of each attribute, definitions, photos and things to take into account when assessing each one.

Attribute 1 –Canopy cover (assessed as projected foliage cover).

Background

- Restoring canopy cover establishes microclimate that supports habitat, healthy ground cover and the suppression of weed growth. In some cases, vegetation can have too little or too much canopy cover, letting in either too much or too little light, impacting on the function and health of the vegetation in general. Achieving the representative canopy cover contributes to ongoing stability within the ecosystem.
- For the purposes of VegCAT, canopy recover equates to *projected foliage cover* and is an assessment of the interaction between the canopy and light reaching the lower strata of the vegetation and ground cover.[1]

Method

When standing at the centre point of the sub-plot, take a photograph looking directly up, from chest height. If using a phone camera, it is easiest to change the camera to 'selfie-mode' for this photograph. Ensure that the camera is held as parallel to the ground as possible. Based on this photograph, assess the total cover provided by the native species canopy (irrespective of the layers). The cover is equivalent to dark versus light. Consider small gaps between leaves as part of the canopy but larger gaps as not part of the canopy. Score the cover with a percentile band and record this in the App or form. The following figures are extracts from other vegetation condition assessment methods, and give guidance on assessing 'canopy cover'.

Issues to be aware of

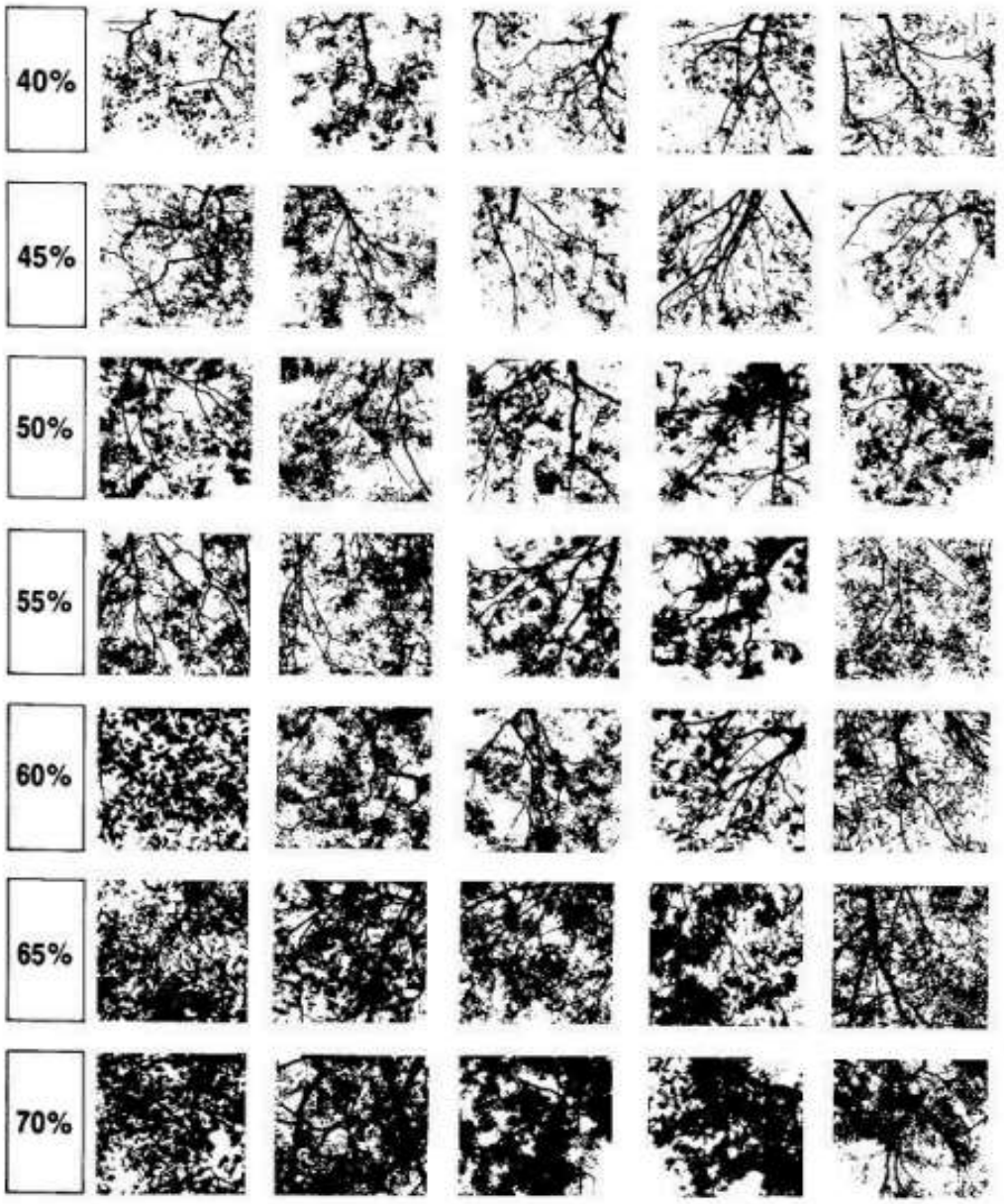
- To the greatest extent possible, only consider the native species that are providing canopy cover. While this is challenging if the canopy is largely made up of weed species, make an effort to determine what percentage of the cover is from native species. The non-native species will be measured in the non-native attribute, and logically, the combination of the two should equate to the total canopy cover.
- In areas with dense understorey, it may be necessary to take the photograph at higher than chest-height, to ensure that the 'dark versus light' image reflects the canopy and not the shrub cover. Where the cover is dominated by shrubs, but lacks any true canopy, make the assessment based on this observation, even if the photograph does not reflect this. Make a note of this variation on the form or in the App.

[1] This assessment differs from BioCondition, which assesses canopy cover by determining the length of the transect which intersects with the 3 strata of canopy (canopy, sub-canopy and emergent canopy). Importantly, this is the method that is used to determine the RE benchmark for this attribute. The previous version of VegCAT (BioCAT) used the transect intersect approach to generate a score based on the result compared to the benchmark. However, this method is complex and resu, resulted in considerable confusion. The results of the different approaches to determining the 'health' were compared for 25 BioCAT plots from a range of vegetation types. Both approaches delivered the same score out of 5 when compared with the benchmark, with a couple of minor exceptions. For this reason, VegCAT has removed the transect intersect method.

Figure 8. Examples of five 'Canopy cover' categories.

Above: From Dixon et al. (2006)

Reference photographs of canopy cover



Source: Walker and Hopkins (1990). Note: canopy cover in rainforest may often exceed 70%.

Above: from Kanowski et. Al (2010)

Attribute 2 – Ground cover

Background

- Ground cover contributes to habitat for ground dwelling species and ecosystem services through water quality and soil erosion services.
- This attribute measures a range of values that provide a picture of ground cover.

Method

- Measured within the 1x1m subplot at points 5, 25, 45
- Allocate a percentage to the following attributes
  - Native perennial grass
  - Native annual grass
  - Native other (e.g. forb)
  - Non-native grass
  - Non-native other
  - Litter
  - Bare ground
  - Other (e.g. rock/water/dead weed mulch)
- Although the full range of ground cover is assessed to arrive at a 100% figure, it is the attributes of native perennial grass cover and organic litter that are taken into consideration in the scoring due to their importance as indications of a healthy vegetation system. Field teams should not spend too much time focusing on the proportions of the other ground cover components.

Attribute 1 Example - Ground cover data collected at the three 1x1m subplots along the 50m transect.

Type of Ground Cover	5m	25m	45m
Native Perennial Grass	5%	20%	60%
Native Annual Grass	15%	20%	10%
Native other (e.g. forb)			
Non-native Grass	20%		
Non-native Other			
Litter	20%	40%	
Bare Ground	35%	20%	30%
Other (e.g. rock/water)	5%		
Total	**100%**	**100%**	**100%**

Figure 8 - In this 1x1m subplot – approximately 60% is 'native perennial grass' while the remaining 40% is bare ground.

Issues to be aware of

- Grass identification between annual and perennial can be complicated without seed heads and good grass identification skills. Where it is unknown, be consistent throughout the plot and make notes for future assessors about the categories that the grass was placed in. Consult someone else with expertise in this area, based on the photographs taken, and where necessary modify the assessment, and make notes for the next round.
- Where species are not able to be identified because they are in young phase, they can be included in the categories 'Native Other', or 'Non-native other'.

Attribute 3 – Native shrub cover

Background

- Trajectory of shrub cover reflects the health of the lower strata of the ecosystem. Too much or too little shrub cover can cause negative effects on the ground cover, and also pose risks to fire management and canopy recruitment. It can also cause impediments for wildlife such as gliders.

Shrub definition - Woody plant that is multi-stemmed from the base (or within 200 mm from ground level) or if single stemmed, less than 2 m tall (Eyre et al. 2015)

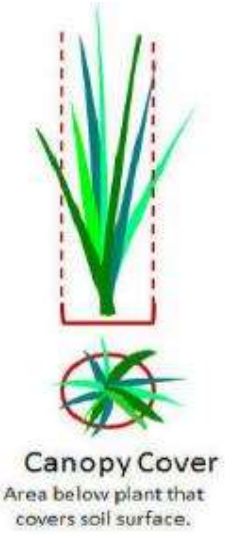
Method

- Measured within the 10x10m subplot area at points 5, 25 and 45m.
- Within the subplot area, estimate the cover made by native shrubs across that area.
- Class the cover that is provided by the shrub layer at that point into a percentage cover band from 0-10% to 91 to 100%.

Figure 9 - In certain vegetation communities, thickening of shrubs can be detrimental to vegetation condition causing changes in fuel loads, and restricting recruitment of canopy species.

Issues to be aware of

- When measuring shrub cover, it includes the gaps between the branches and twigs as shown in the adjacent diagram.



Attribute 4 – Recruitment of woody canopy species

Background

- An increase in natural woody recruitment indicates that the plot is healthy and has processes to allow for vegetation succession. Conversely, if recruitment is dominated by non-preferred native species (e.g. woody thickening) or non-native species, this could indicate that condition is potentially declining over time.
- Woody recruitment for VegCAT is split into 3 classes
    1. Preferred native – species that the project aims to support such as canopy species
    2. Non preferred native – species that are not the focus of the project
    3. Non-native canopy species

Recruitment of woody species - species with a woody stem less than 5cm diameter at breast height (DBH) (Eyre et al. 2015). Focus is on the species that are part of the canopy (species key to that ecosystem) however can also measure other native perennial species that may influence the canopy or sub canopy.

Method

- Measured within the 10x10m subplot area at 5, 25 and 45m.
- Count all woody recruits in the subplot area that are above 0.5 metres (indicating that they have pushed through any initial mass recruitment, and are quite likely to be successful in progressing further towards the canopy). This count will be broken down into the following categories
    - Preferred native canopy species
    - Non-preferred native canopy species
    - Non-native canopy species
- Each tallied total is recorded. Where very high numbers of woody canopy recruits occurs in the sub-plot, measuring just a quarter of the sub-plot and multiplying the total by 4 will save time. If this approach is adopted, ensure the same quarter is assessed in every sub-plot (e.g. top right hand quarter).
- A rating of the overall health of natural recruitment of the plot will also be undertaken according to the categories in the box below. This categorical assessment will be undertaken at the end of the plot assessment.

Figure 10: High numbers of woody recruits can occur in rainforest scenarios. In this case counting recruits in half the subplot would be sufficient to ensure a representative result.

Issues to be aware of:

- This attribute can be time consuming and where high numbers of recruits are found, counting half the subplot and multiplying by 2 can save time. If you choose this option, count all recruits on either side of the transect tape ***out to 2.5 metres only. This equates to half the sub-plot.*** This approach also has the advantage that you don't need to stomp through a 10X10 plot with high grass or other shrubby vegetation that might hide evidence of recruits.
- It may be difficult to determine what is 'preferred' and 'non-preferred'. In this case, take notes and seek expert advice after the assessment. If necessary, change the rating that is undertaken at the end of the plot (e.g. if you discover than a large proportion of the recruits that you thought were preferred canopy species were in fact non-native species).

Summary Rating – to be entered at the end of the VegCAT Assessment

Attribute 3 – Natural Recruitment

Purpose is to assess the health of natural recruitment across the whole plot, and the extent to which this is likely to support successional processes in moving towards improved vegetation condition. By recruitment, we are referring to the recruitment of trees – those seedlings which are likely to become canopy/sub-canopy species. For the purposes of this indicator/attribute we are not referring to the natural recruitment of shrub species.

Key signs to be looking for when considering what healthy natural recruitment would look like include:

- The majority of preferred, native canopy species present as recruits;
- They are in sufficient numbers to support natural succession
- Presence of preferred native sub-canopy species as recruits;
- Canopy species present are in a number of different age classes;
- Canopy species present are well distributed throughout the plot; and
- Natural recruitment is not obviously impeded by other threats/threatening processes.

Key question is: To what extent is natural recruitment supporting the successional processes necessary for healthy (improving) native vegetation?

Rating 0 – There are no signs of recruitment of native (preferred) species.
Rating 1 – There are very limited signs of recruitment of native species (e.g. Only 1 of the above signs)
Rating 2 – There is limited sign of recruitment of native species (e.g. only 1-2 of the above signs).
Rating 3 – There are moderate signs of recruitment (e.g. a few of the above signs only).
Rating 4 – There are good signs of recruitment (e.g. most of the above signs).
Rating 5 – There are very good signs, with the ecosystem showing all signs of healthy natural recruitment.

Attribute 5 – Non-native plant cover

Background

- Non-native species are a significant threat to ecosystem condition through changes to habitat and competition for resources.
- Measuring this change, which is often linked to the purpose of funding applications, will provide an indication of the success of the project.
- Importantly, assessing the threat of these non-native plant species to the current and future integrity of the vegetation is important.
- The non-native plant cover will be measured at three different levels.
    a) Canopy and sub-canopy cover
    b) Shrub cover
    c) Ground cover

Attribute 5 Example – non-native cover recorded over 3 10x10m subplots

In the below dataset, weeds are present in all three layers. Camphor laurel is measured in the canopy/sub canopy layer and in the shrub layer when young trees are less than 2m tall. Cats claw vine is measured as a ground layer and as a canopy/sub canopy where it grows up woody species and smothers the canopy. The species data is entered in at the end to show how it is captured all layers.

	5m	25m	45m
Canopy and sub canopy			
Total	**15%**	**20%**	**30%**
Shrub			
Total	**40%**	**10%**	**10%**
Ground Cover			
Total	**60%**	**80%**	**20%**

Key Species – Camphor laurel, Cats Claw Creeper.

Method for all three categories

- Measured within the 10x10m plot area at points 5, 25 and 45m.
- Estimate the amount of cover of non-native plants at each of the 32 layers.
- Assessing non-native plant cover within a 10% band is sufficient.
- The first measure is canopy and sub-canopy cover which includes any non-natives that are above the shrub layer. This is repeated for shrubs and ground cover.
- At the end record the key species that were present within the whole plot. This does not have to be a comprehensive list, but should include the key non-native plant species that are of particular concern.
- A rating summary of the threat of non-native plant species across the plot will also be entered as shown in the below box. This assessment will be undertaken at the end of the plot assessment.

Issues to be aware of

- The same species may be measured for different layers. For examples vines may contribute to the canopy, shrub and ground layer (e.g. rubber vine).
- If there is uncertainty about whether a plant is a weed, take photographs, record comments about its distribution and seek expert opinion. If necessary, adjust the rating after returning from the field, which will alter the score.

Figure 12 - Cats Claw Creeper can be measured in both canopy and ground layer. VegCAT will track how each layer cover will change over the four years.

Summary Rating – to be entered at the end of the VegCAT Assessment

Attribute 5 – Non-native plant cover

The purpose of this categorical assessment is to provide an overall assessment of the threat of weeds at that point in time. Things that need to be taken into consideration when arriving at an assessment choice include:

- **The type of weeds** – if there are transformer weeds present they are obviously of greater concern than ephemeral weeds that will not have the same overpowering and degrading impact as transformers.
- **Extent of weeds** – in combination with the above, the sheer extent of the weeds within the whole plot needs to be considered.
- **Growth form/stage** – this could relate to whether this is a mature and frequently seeding weed (e.g. a mother tree), or whether the weed is present in the ground, shrub and canopy layer (e.g. might be the case with rubber vine).

Key question: To what extent are non-native plants a threat to the condition of the native vegetation in the plot?

Rating 0 – Non-native plants are causing complete collapse of the ecosystem (*Non-native plants are causing the ecosystem to be non-functional*)

Rating 1 – Non-native plants are causing a significant impact on the condition of the vegetation. (*The ecosystem is barely functioning, or likely to cease functioning in the next few years*)

Rating 2 – Non-native plants are causing a high level of impact on the condition of the vegetation (*Causing a significant reduction in ecosystem function, or may not function at all in the next 10 years)*

Rating 3 – Non-native plants are causing a moderate level of impact on the condition of the vegetation (*Causing a concerning reduction in ecosystem function)*

Rating 4 – Non-native plants are causing a low level of impact on the condition of the vegetation *(Causing limited/minor changes, but the ecosystem will maintain on-going function*).

Rating 5 – Non-native plants are not causing impact on the condition vegetation (*There may be no weeds present, or the weeds present do not impact the function of the ecosystem*).

Changes in vegetation/ecosystem function – signs to look for include:

- *Loss of recruitment or change in the species that are able to recruit*
- *Loss of species richness leading to less habitat for flora and fauna*
- *Changes in microclimate such as increases in cover, loss of cover, loss of strata, or gain in strata.*
- *Loss in the ability to perform ecosystem services such as maintain water quality.*

Attribute 6 – Animal soil disturbance

Background

- Animal disturbance to the soil layer impacts ground cover, ability for species to recruit and may reduce habitat value.
- Measuring the change of disturbance within the plot will help determine how the project has managed, mitigated or reduced any disturbance.

Key Definitions

Pugging – Area where deformation of the soil surface has occurred as a result of hooved animals traversing the area in wet/muddy conditions. This includes disturbance of the soil surface caused by pigs digging or wallowing.

Trampling – visible disturbance to the soil surface caused by hooved animals traversing the area in dry conditions.

Method

- Measured within 10x10m subplot area at points 5, 25 and 45m.
- Estimate the amount of ground disturbance by animals within the subplot. This includes disturbance caused through:
    - Pig rooting or wallowing; or
    - Cattle pugging, trampling or camping
- This amount of disturbance will be entered as 10% band.
- A rating summary of revegetation of the plot will also be entered as shown in the below box. This assessment will be undertaken at the end of the plot assessment.

Figure 13: Evidence of pugging in the right hand side caused by hooved animals.

Figure 14: Evidence of pig rooting

NB: the rating for animal disturbance IS NOT included in the final VegCAT score. This is because the anticipated implications of reduced disturbance (e.g. improved ground cover and natural recruitment) will be measured independently and will contribute towards the score. Including animal disturbance would essentially duplicate its contribution to the condition score.

Summary Rating – to be entered at the end of the VegCAT Assessment

Attribute 6 – Animal Soil Disturbance

Purpose is to assess the severity of animal soil disturbance/damage at that point in time over the whole plot, with a focus on the impact of this disturbance on the condition and function of the native vegetation. Consideration needs to be given to both the extent, nature and impact of the disturbance.

Key question: To what extent is animal damage/disturbance a threat to the condition of the native vegetation in the plot?

Rating 0 – Animal disturbance is causing complete collapse of the ecosystem (*Animal disturbance is causing the ecosystem to be non-functional*)

Rating 1 – Animal Disturbance is causing a significant impact on the condition of the vegetation. (*Causing changes to vegetation function that the ecosystem overall is barely functioning, or likely to not to function in the next four years*)

Rating 2 – Animal Disturbance is causing a high level of impact on the condition of the vegetation (*Causing changes to vegetation function that the ecosystem overall has a significant reduction in function, or may not function in the next 10 years)*

Rating 3 – Animal Disturbance is causing a moderate level of impact on the condition of the vegetation (*causing changes to vegetation function that the ecosystem has a reduction in function)*

Rating 4 – Animal Disturbance is causing a low level of impact on the condition of the vegetation (*causing small changes to vegetation function, but the ecosystem will maintain ongoing function*).

Rating 5 – Animal Disturbance is not causing impact on the condition vegetation (*There may be no animals present, or the animals present do not alter the function of the ecosystem*).

Changes in vegetation function

- *Loss of recruitment or change in the species that are able to recruit*
- *Loss of species richness leading to less habitat for flora and fauna*
- *Changes in microclimate such as increases in cover, loss of cover, loss of strata, or gain in strata.*
- *Loss in the ability to perform ecosystem services such as maintain water quality.*

Attribute 7 –Revegetation survival

Background

- Areas that have revegetated may be subject to loss through such things as frost, drought, trampling or fire. Measuring the survival rates of revegetation assesses the likelihood of successful ecosystem regeneration and provides evaluation on the success of the planting.

Method

- Measured within the 10x10m subplot at points 5, 25 and 45m.
- Estimate the survival of planting in 10% bands. This is based on the knowledge that assessors have in relation to the number of trees planted as well as visual evidence of losses.
- Enter in the average height of plants.
- A rating summary of how close the revegetation is to self-sufficient will also be entered as shown in the below box. This rating will be undertaken at the end of the plot assessment. It is anticipated that in the early years, although you might be very satisfied with the growth rates and survival of the revegetation, it will not yet be at a self-sufficient state.

Figure 11 - In this scenario the percentage is easy to calculate based on the evidence of the tree guards.

A box for comments in relation to the revegetation is provided to add any context to the rating.

Issues to be aware of

- Use the data captured in the **Condition Monitoring Plan** to determine what the average planting density was at the start. This information can be used to inform the current survival rates of the revegetation.

NB: the rating for revegetation survival IS NOT included in the final VegCAT score. This is because the anticipated implications of successful revegetation is reflected in most of the other attributes (e.g. canopy cover, increased canopy height, reduced non-native plant species, improved ground cover and natural recruitment). However, rating the success of the revegetation can be useful for management, and provide site-specific data for reporting.

Summary Rating – to be entered at the end of the VegCAT Assessment

Attribute 4 – Planting revegetation

Purpose is to assess the progress of a revegetation area towards self-sufficiency at that point in time. It is important to note that a low score could indicate a new/young site, or a site that has been disturbed. Therefore a low score at an early stage of the revegetation is not necessarily a bad thing – more an indication of its current stage. Things that could to be taken into consideration when arriving at an assessment choice include:

- The overall survival rate of the trees
- The growth of the seedlings
- The health of the seedlings
- The extent to which the revegetation is being held back by things like weeds, predation, frost, insect damage etc.

Key question: To what extent has your revegetation plot reached a self-sufficient state?

Rating 0 – Revegetation is not present – there is currently no revegetation works on the site, or the site has completely died and requires an entire new planting.

Rating 1 – Not at all – the plantings are still small or have been disturbed in their growth by an external pressure (some of the plants have died and some re-planting is required).

Rating 2 – It is doing OK, but still young and vulnerable with a lot of maintenance effort still needed and/or a lot of the revegetation has died and needs significant in-fill planting.

Rating 3 – It is well on its way but still has a way to go and requires considerable maintenance effort and/or moderate amounts of in-fill planting.

Rating 4 – It is almost there, but still needs ongoing checking and weed control to ensure adequate canopy closure.

Rating 5 – We are confident that the site is self-sufficient. We have satisfactory canopy closure and no further maintenance is required.

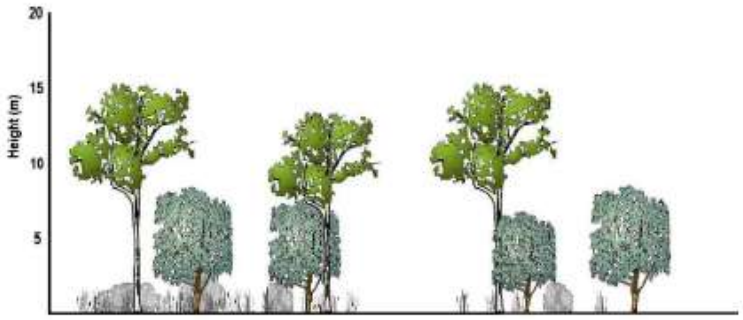
Attribute 8 – Dominant canopy height

Background

- Dominant canopy height indicates the broad state of the vegetation community. In a regrowth or revegetation area, this attribute should show signs of increase within a four-year timeframe.

Method

- Measured within the 10 x 50m plot
- Find the dominant canopy layer that represents the plot area as defined in the **Condition Monitoring Plan**
- For mature area, this would be the canopy layer made up of Eucalypt species or rainforest species.
- For revegetation areas, this would be the height of the dominant vegetation layer within the revegetation area. This could be varied, but the dominant layer should be measured. To measuring tall canopy – can use the clinometer method or the stick method. See Appendix 4 for an example
- For low revegetation – measure via a tape measure from the ground to the top of the plant. If the plot is diverse, a number of measurements could be made and averages can be made.



RE 6.5.3 *Eucalyptus populnea* woodland with *A. aneura* subcanopy

Scenario 1 – This community is dominated by Eucalyptus canopy species. Measure the height of the representative eucalypt, which would be approximately 15m.

Most *Eucalyptus populnea* cleared

Scenario 2 – This community is dominated by an Acacia sub-canopy layer, however representative canopy species occur at lower density.

As the acacia sub-canopy is the dominant canopy, the height to be recorded would be approximately 8m.

All vegetation cleared. Single layer of regrowth.

Scenario 3– This community is dominated by Acacias and Eucalyptus as part of regrowth succession or revegetation.

The dominant canopy is represented by both species and the measure would approximately 5m.

Figure 15: Different scenarios showing the dominant canopy layer taken from Eyre et al. (2015)

Step by step guide to laying out plot and measuring attributes.

Below is a sequence of steps to guide assessing officers with the implementation of a new plot based on 10x10m subplots.

Step 1 – Find the start point of the transect and run the 50m tape measure in a straight line along the proposed transect.

Step 2 – Drive in a star picket or equivalent at points 0m, 10m and 50m, which will be markers for the transect in future years and for photo points. Drive in additional star pickets if the 10x10m plots are to be installed permanently.

Step 3 – Walk to 0m and take a photo looking along the transect keeping the 10m star picket in the centre of the picture.

Step 4 – Walk to the 5m mark along the transect. Take a photograph looking up and looking down (the App also asks for photos looking left and right).

a) Using the 'photo up' taken at chest height for reference/assistance, estimate the total ***native*** **canopy cover (attribute 1)** within the nearest 10%. No need to distinguish between canopy and sub-canopy cover.
b) Place the 1m x 1m quadrat over the 5m mark and estimate the **ground cover composition (attribute 2)**.
c) Place 2 x 10m length ropes perpendicular to the 0m and 10m marks on the transect.
d) Using the rope to create a visual 10x10m plot estimate the **shrub cover (attribute 3)** within that area.
e) Count the **woody tree recruits (attribute 4)** *above 1 metre* in that area. Doing this quarter by quarter is helpful. If there are too many recruits do only 1 or 2 quarters and multiply by 4 or 2 (always count in the same quarters for the plot). Record the total number of 'Preferred Native', 'Non-preferred native' and 'Non-Native' recruits.
f) In the same 10x10m plot, estimate the cover of **non-native plants in each layer (canopy/sub-canopy, shrub and ground) (attribute 5).**
g) In the same 10x10m plot, estimate the area impacted by **animal disturbance (attribute 6)**.

Above: The plot with 3 star pickets along 50m tape

Above: Example of main photo point with 10m star picket in centre of photo

Above: Example of 1x1m quadrat over 50m transect.

h) Where applicable to your plot, in the same 10x10m plot, estimate the **% survival of revegetation (attribute 7)** in the area and the height of the trees planted.

Step 5 – Repeat Step 4 at 25m and 45m.

Step 6 – At the end of the transect, take a photo looking down the tape measure towards the 0m mark.

Step 7 – At the 50m mark, look back and determine the representative dominant canopy layer within the 10x50m plot and measure the **average canopy height (attribute 8).** Ideally, you would have been taking notice of this as you progressed through the 10X10 sub-plots. This can be measured through:

a) Clinometer method for tall vegetation;
b) Tape measure for young revegetation or regrowth.

For those without access to the VegCAT survey 123 App, or who prefer to gather data in the field using a paper form, an example form is provided below.

Example Scoring Sheet

Date:	Officer:	VegCAT Plot reference:	GPS coordinates:	Plot Bearing:
RE:		Area History/Comments:		

	Attribute		1 (5m)	2 (25m)	3 (45m)	Average	Comments/Species Notes	Rating where applicable for whole plot (circle)
1x1m Plots	Canopy Cover							
	Ground Cover	Native Perennial Grass						
		Native Annual Grass						
		Native Other (forb)						
		Non-native forbs						
		Non- native grass						
		Litter						
		Bare Ground						
		Rock or other						
10x10m Plots	Shrub Cover							
	Recruitment (No.)	Preferred Native						Overall Rating Rating 0 Rating 1 Rating 2 Rating 3 Rating 4 Rating 5
		Non- Preferred Native						
		Non-Native						
	Non-Native Plant Cover	Canopy						Overall Rating Rating 0 Rating 1 Rating 2 Rating 3 Rating 4 Rating 5
		Shrub						
		Ground						
	Animal Disturbance (%)							Overall Rating Rating 0 Rating 1 Rating 2 Rating 3 Rating 4 Rating 5
	Revege-tation	Survival						Overall Rating Rating 0 Rating 1 Rating 2 Rating 3 Rating 4 Rating 5
		Height						

		Measurement	Comments
10x50 m plot	Tree Canopy Height		

Section 3: Scoring VegCAT

VegCAT Scoring Methodology

The VegCAT scoring is reliant on the site having a set of benchmark data available (preferably an official RE benchmark from the Queensland Herbarium, and if not, the best determination based on literature and expert opinion). See the adjacent box for more information on benchmarks and the section below for addressing gaps in the availability of Regional Ecosystem benchmark data.

BioCondition Benchmarks.

BioCondition benchmarks are values developed by Queensland Herbarium to describe the reference state of regional ecosystems. These values are used for BioCondition and VegCAT to score the sites. To view the available benchmarks, visit the following site: https://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks

The scoring will occur through two methods.

- Native Perennial Grass Cover, Litter, Canopy Cover, Canopy Height and Shrub Cover will be scored based on a comparison of the observed value with the RE Benchmark (see Table 3). This method aligns with BioCondition. However, for some attributes where a more sensitive record of change over shorter timeframes is required, VegCAT has modified some comparison scores to build in more 'steps' between the lowest and highest possible score.
- Where the attribute has a ratings category (recruitment, non-native plant cover) the ratings will be used to calculate the score.

The *revegetation* rating is not included in the score as it provides a summary of a number of the attributes (e.g. canopy height and cover) and would result in double counting. This rating however can be used to help describe sites that are subject to revegetation in a rapid method. Similarly, it has also been decided that the *animal disturbance* rating will not be included in the score, primarily as other attributes are likely to demonstrate change in response to less disturbance (e.g. ground cover, natural recruitment). However, both the revegetation and animal disturbance ratings are important for tracking direct project progress, and can be used in shorter timeframes to demonstrate project achievements, if the response in other attributes is not yet realised.

Once all the scores are determined for each attribute, they are summed. The result will be a number between 0 and 50 – with 50 being the highest possible score when taking all scored attributes into consideration. The total is then doubled to provide a score between 0 and 100.

Different attributes have different weighting. Some attributes are only scored out of 5, while others are scored out of 10. This weighting has been decided to allow for greater sensitivity to changes for some attributes over the course of the 4-year project. The attributes with a higher weighting include perennial grass cover, natural recruitment and non-native plant cover.

The below table describes the scoring for each attribute.

NOTE: *Scoring against RE benchmarks will be automated as part of the* ***VegCAT Survey 123 App****. These scores will be available once all the data has been entered correctly into the App.*

Determining RE benchmarks if not currently available

In some instances, Regional Ecosystem benchmarks are not available. Where there is no benchmark data for the Regional Ecosystem/s within which the project is being implemented, these will need to be determined for the VegCAT attributes that require this information to generate a score (see table below). A VegCAT score cannot be generated without these measures. Determining the benchmarks will require consultation with Herbarium staff, local experts and available data through historical surveys or reports. Any benchmark data should be documented in the Condition Monitoring Plan and can then be transferred in the Survey 123 app (the CSV file that accompanies the back-end of the system). This will enable scores to be determined. If there are changes in the chosen benchmark figure over time, scores can be adjusted accordingly. However, the best effort should be invested to get the figures as close as possible, in order to avoid re-work of the data down the line.

Table 5: VegCAT Scoring Methodology

Attribute	Measure	How is it scored	Maximum possible score	Score (and method for score generation)
1. Canopy Cover	Generate an average value from the 3 recorded measures	Transect interval value compared against BioCondition benchmark	5	0 = <10% of benchmark OR >250% of benchmark 1 = 10-20% OR 225-250% of benchmark 2 = 20-30% OR 200-225% of benchmark 3 = 30-40% OR 175-200% of benchmark 4 = 40-50% OR 150-175% of benchmark 5 = >50% of AND <150% of benchmark (Based on preliminary scoring graph provided by Don Butler) *Where the site has a canopy and sub-canopy value, these are scored separately against the benchmark and averaged.*
2a. Perennial Grass	Generate an average from the 3 values recorded in the 1x1m quadrat.	Compared against BioCondition Benchmark	10	0 = <10% of benchmark native perennial grass cover 2 = 10-30% of benchmark native perennial grass cover 4 = >30% - 50% of benchmark native perennial grass cover 6 = >50% - 70% of benchmark native perennial grass cover 8 = >70% - 90% of benchmark native perennial grass cover 10 = >90% of benchmark
2b. Litter	Generate an average from the 3 values recorded in the 1x1m quadrat.	Compared against BioCondition Benchmark	5	0 = <10% of benchmark 3 = 10-50% or >200% of benchmark 5 = >50% or <200% of benchmark
3. Native Shrub Cover	Generate an average from the 3 values recorded in the 10x10m plot	Compared against BioCondition Benchmark	5	0 = <10% of shrub cover 3 = >10% or >200% of shrub cover 5 = >50% or <200% of shrub cover
4. Recruitment	Rating of 0-5 based on assessment of natural recruitment characteristics.	Ratings used to create score.	10	0 = Rating 0 2 = Rating 1 4 = Rating 2 6 = Rating 3 8 = Rating 4 10 = Rating 5
5. Non- Native Plant Cover	Rating of 0-5 based on assessment of non-native plant cover characteristics	Ratings used to create score	10	0 = Rating 0 2 = Rating 1 4 = Rating 2 6 = Rating 3 8 = Rating 4 10 = Rating 5
6. Animal Disturbance	Rating of 0-5 based on assessment of animal disturbance characteristics	Not scored.		N/A – rating used for reporting directly about the reduction in animal disturbance, as opposed to improvement in condition, which should be captured through the other attributes (e.g. ground cover, natural recruitment)
7. Revegetation	Rating of 0-5 based on assessment of natural revegetation characteristics.	Not scored.	N/A	N/A – rating used for reporting directly about the success of revegetation, as opposed to improvement in condition, which should be captured through the other attributes (e.g. canopy height and cover, weeds)
8. Canopy Height	Height value recorded within the plot	Compared against BioCondition benchmark	5	0 = No canopy (height = 0) 1 = 1-10% of height 2 = >10-25% of height 3 = >25-50% of height 4 = >50-75% of height 5 = >75% of height
Total possible score			**50**	**50 X 2 provides a score out of 100.**

References

CSIRO. (2009) *Australian Land and Soil Survey – Field Handbook.* CSIRO Publishing, Melbourne.

Dixon, I., Douglas, M., Dowe, J., Burrows, D. (2006) *Tropical Rapid Appraisal of Riparian Condition – Version 1 (for use in tropical savannas).* River and Riparian Land Management Technical Guideline.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2*. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Kanowski, J., Catterall, C. P., Freebody, K., Freeman, A. N. D. and Harrison, D. A. (2010) *Monitoring Revegetation Projects in Rainforest Landscapes. Toolkit Version 3*. Reef and Rainforest Research Centre Limited, Cairns (98pp.).,3; 2010

Appendix 1 – VegCAT Condition Monitoring Plan (template)

Introduction

The purpose of the **Condition Monitoring Plan** is to record your logic and reasoning for how you are approaching monitoring changes in the condition of your native vegetation project. The plan sets out your decisions, but also your reasoning (rationale) behind those decisions. The plan also specifies what you are hoping to see change against each of the attributes, including where possible, any information about the species you want to see more of and those you want to see less of. Through documenting the background to the project, the plan provides:

- ***Credibility*** – it is the basis for demonstrating the credibility of your approach to monitoring (and requires you to think through and then justify your monitoring decisions); and
- ***Clarity*** – it records the decisions you made at the beginning of the project and why, and ensures that everyone has the same understanding of your condition monitoring approach (including new people coming into your project team).

Summary Project Information

SWIF project identification	
Planning team	
Key Dates	
- Completion of Condition Monitoring Plan	
- Baseline data collection	
- On-ground works	
- Follow-up monitoring	
- *Add additional as necessary*	

Summary Vegetation Information

Regional Ecosystem	Key Canopy Species	Canopy Layer Height	Biocondition Benchmark information available
4.9.2	*Acacia cambagei*	*6-10m*	*Yes/no*

NB: refer to VegCAT Guidelines if benchmark data not available for regional ecosystems.

Short summary of what the project is trying to achieve

Please provide a succinct description (a paragraph would be enough) of what the project is trying to achieve – this could be from the project application for example. The summary should be clear about what the threats are, and what success would look like at the end of the project.

Approach and rationale for determining assessment units, and the location of the VegCAT plots (how many and where)

Please describe how you will lay out your VegCAT plots – how many and where. Please provide a justification for how you arrived at this plan. What did you take into consideration, why did you make the decisions you made?

NB: if you have more than one site for this project – and your rationale for determining plot number and location is different, you could include commentary of both/all sites (e.g. Site A; Site B). You would then include aerial photos for

each at the end. Feel free to have multiple tables for different sites, if you anticipate that the anticipated changes will be quite different.). Alternatively you could have a separate ***Condition Monitoring Plan*** *for each project site.*

Approach and rationale for determining monitoring timing and frequency (when and how often)

Please describe when you will conduct your monitoring each year (if annually). Note: the best approach is to revisit the monitoring plot at the same time of year. Please specify how often you will revisit the monitoring plots. Please provide a short justification for these decisions.

Expectations at end of project against the specific Attributes

Please complete the following table, specifying what change you hope to see against each of the attributes. For some attributes there may be no expected change. This is fine. Where you are hoping to see a reduction or increase is specific species, it would be helpful to note this. However, it is not anticipated that you would need to include a lot of species-specific information in this table.

Attribute	Expectation of the difference you will see against this attribute by the end of the project
1. Canopy Cover (includes sub canopy cover).	
2. Ground cover incorporating • **Native perennial grass** • **Native annual grass** • **Non-native grass** • **Non-native other** • **Litter** • **Bare ground** • **Other (rock, water)**	
3. Shrub cover	
4. Recruitment of woody species split into **a) Preferred native species** **b) Non-preferred native species**	
5a. Non-native plant cover (canopy and sub canopy)	
5b. Non-native plant cover (Shrub)	
5c. Non-native plant cover (ground)	
6.Animal Soil Disturbance	
7a. Success of planting/ revegetation – seedling survival rates	
7b. Success of planting/ revegetation – height of planting	
8. Dominant Canopy Height	

Other Expectations not captured through attributes

If there are other changes that you expect to see, that are not captured in the above attributes, this is an opportunity to record these.

Map of project area with monitoring plots indicated (including separation of assessment units).

Please include a map of your project delineating assessment units and the VegCAT plots. Include any other useful information as required on the map. Ideally, this map would be based on an aerial photograph so that landscape features can be seen.

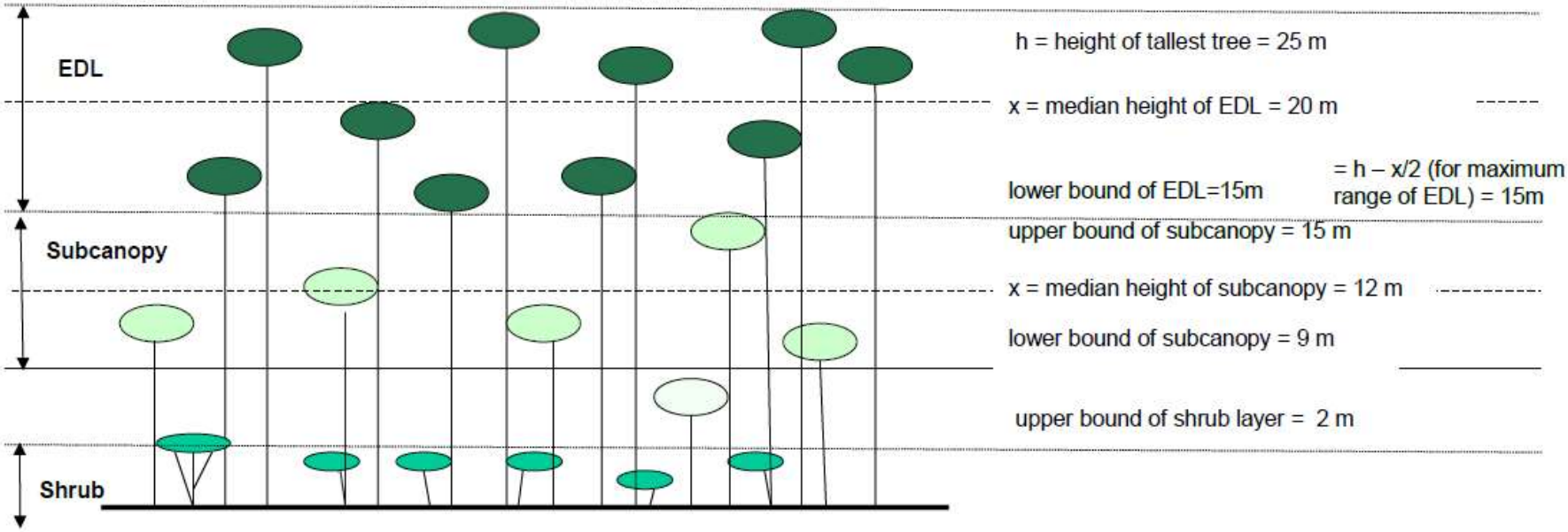
NOTE: A laminated copy of this monitoring plan will be an important tool in your monitoring tool kit, so that it can be referred to in the field if necessary.

Appendix 2 – Optional Attributes

The below attributes are optional and can be collected to provide further data to inform condition changes to the vegetation. They will enable a more complete BioCondition assessment of the site. Ideally, at the beginning of a project, the full BioCondition assessment would be conducted at a couple of the VegCAT sites. VegCAT data can be nested within this broader BioCondition assessment.

Attribute	Description	Area to be collected	Method
Large Trees	Large trees are critical to habitat values. Large trees are defined by the regional ecosystem benchmark. If no benchmark is available, generic thresholds of >20cm DBH for non-eucalypts and >30cm DBH for eucalypts can be used.	Where possible in a 100x50m plot	See BioCondition
Native Species Richness	This captures the number of different species in Trees, Shrubs, Forbs and Grasses.	To be collected within the 10x50m plot	See BioCondition
Coarse Woody Debris	Measures the value of habitat values on ground through the amount of woody debris present in the vegetation community. The more debris, the greater the habitat value.	To be measured within the 20x50m plot	See BioCondition
Animal Vegetation Disturbance	Option to measure the disturbance to vegetation from animal browsing.	To be estimated within 10x10m subplots	Not part of BioCondition, so if measured will need to be documented in the **Condition Monitoring Plan** on repeatable method of how the disturbance is measured, rated or quantified.

Box 9: Method to determine vegetation strata, when not obvious



1. The median EDL tree height (x) is 80% of the height of the tallest tree (excluding emergents).
2. The height range for the EDL = x/2
3. The lower height bound of the EDL = h – x/2.
4. Repeat the process to obtain the height range for the subcanopy.
5. The shrub layer contains all woody plants that are either multi-stemmed from the base (or within 200 mm from ground level) or if single stemmed, less than 2 m tall.

Example (above diagram): height of tallest tree h = 25 m. Therefore the height range for the EDL is 15 to 25 m with a median = 20 m (80% of h); the subcanopy is 9 to 15 m, the shrub layer is <2 m.

Appendix 3 – Canopy Cover attribute: Method to determine Vegetation Strata

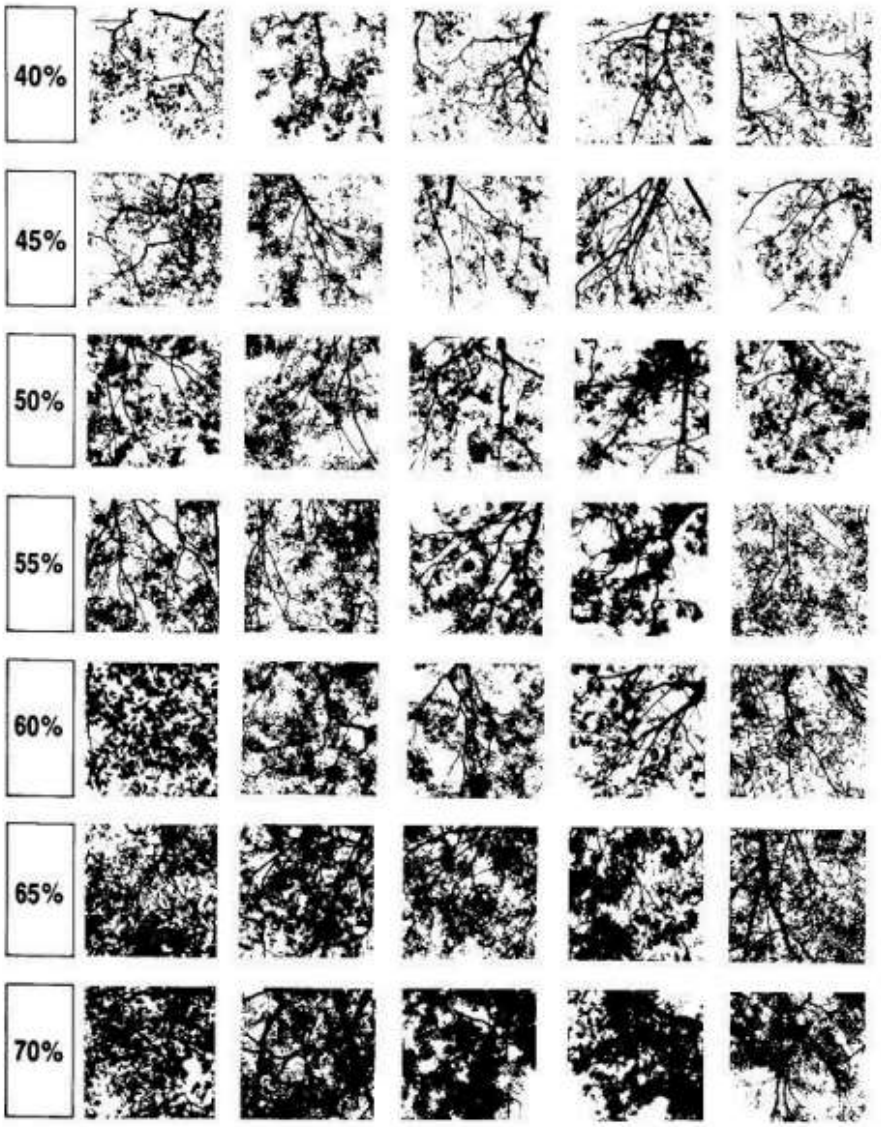
Guides for estimating 'canopy cover' in subplots

From Dixon et al. (2006)

Figure 8. Examples of five 'Canopy cover' categories.

From Kanowski et. Al (2010)

Reference photographs of canopy cover



Source: Walker and Hopkins (1990). Note: canopy cover in rainforest may often exceed 70%.

Appendix 4 – Method to measure tree height

The following methods are taken from Eyre et al. (2015).

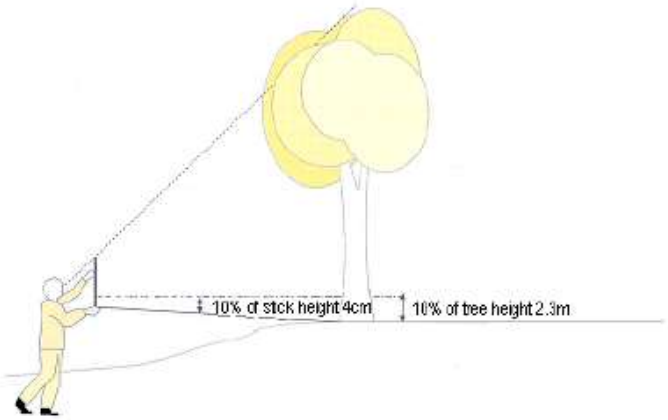
a) Stick or pencil method

(Extracted from Abed, T., and Stephens, N.C. (2002). *Tree measurement manual for farm foresters - Practical guidelines for farm foresters undertaking basic inventory in farm forest plantation stands*. National Forest Inventory, BRS, Canberra.)

1. Take a straight stick of known length (preferably 30 – 40 cm long)
2. Place a mark on the stick at the point 1/10th of its length from the bottom. For example, if the stick is 30 cm long, place the mark at 3 cm from the bottom.
3. Holding the stick vertically at full arm's length, walk backwards from the tree you wish to measure, until the top and bottom of the stick match with the top and bottom of the tree.
4. Note where your mark lines up with the tree trunk and have your co-worker, standing at the tree, put their hand up to this point on the tree trunk. Then measure the distance from the ground to this point on the tree. Call this the 'tree mark height'.
5. As the mark on the stick was 1/10th of it total length, the mark on the tree is also 1/10th of the total tree height. Therefore multiply the tree mark height by 10 to get the total tree height.

Hint 1: Depending on the height of the trees you may need a longer or shorter stick. Alternatively a tape measure or ruler can be used instead of a stick.

Hint 2: The stick or pencil method has the disadvantage of having a high level of error and is time consuming. It is recommended that, if possible, a vertex hypsometer or clinometer (see next section) should be used to determine tree height. Optical hypsometers use lasers to calculate the horizontal distance to the tree, and then automatically calculate the height of the tree once the angle to the highest part of the tree and to its base is recorded.



b) Clinometer method

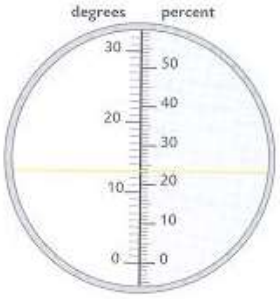
(Extracted from Abed and Stephens 2002)

The Suunto clinometer (clino) is a tool commonly used by foresters to measure tree heights and slope angles. At the rear of the clino is a peephole, which shows a percentage scale and a horizontal line (see figure below).

1. First measure the horizontal distance between the base of the tree and the operator.
2. Looking through the peephole, line up the horizontal line with the top of the tree (the highest part of the tree—usually foliage) and read off the corresponding number from the percentage scale, which is on the right hand side. The scale on the left is in degrees and should not be used.
3. Line up the horizontal line with the base of the tree and again read off the corresponding number from the percentage scale.
4. If the base of the tree is above you (i.e. you're on the downward slope) then subtract the number from step 3 from the number in step 2 and multiply by the horizontal distance to get a total tree height.
5. If the base of the tree is level with you or below you (i.e. you're on the upward slope) then add the numbers together and multiply by the horizontal distance to get a total tree height.
6. If the tree is leaning, stand at right angles to the lean so the tree isn't leaning towards or away from you. If the highest part of the tree is not directly above the trunk, then adjust the horizontal distance so that it relates directly to the highest part of the tree.

Hint: If you can't see the bottom of the tree because of branches or understorey, sight to a point up the stem that can be seen and treat this as the base of the tree and continue with the procedure as described above. Then add the height from the base to the point you could see to get your estimate of total height.

Looking through a clinometer



Using a clinometer

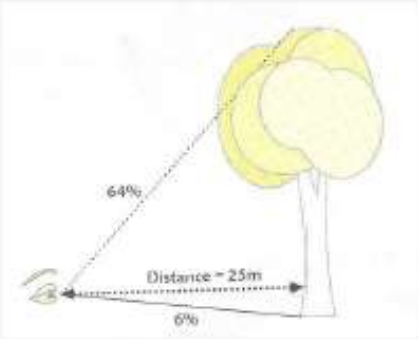
The heights of the crown can also be measured using a laser instrument called a hypsometer. Where the top of the tree is not directly above the base of the trunk, it is important to also measure the point directly below the highest point of the tree canopy to get an accurate crown height.

EXAMPLE:

Jenny wants to determine the height of two trees, with the first tree slightly below her and the second tree slightly above her. Using a tape measure, she measures the distance between her and the first tree, which is 25 m away. Using the clinometer, she sights to the top of the tree and sees the horizontal line align with the percentage number 64, she then sights to the base of the tree and finds the percentage number to be 6. She adds both percentage numbers and multiplies the distance to get a tree height of 17.5 m.

Tree height = 25 x (0.64 + 0.06)

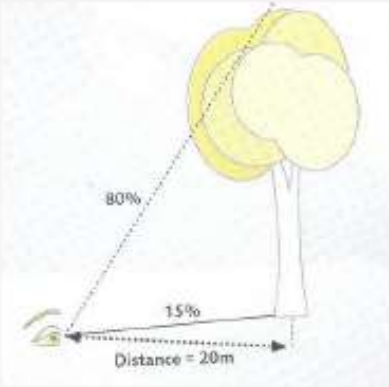
= 17.5 m



Jenny then repeats the procedure with the second tree and measures a distance of 20 m from the tree. The percentage to the top of the tree is 80. The percentage to the bottom of the tree is 15. Therefore tree height of the second tree is 13 m.

Tree height = 20 x (0.8 –0.15)

= 13 m



N/A