AfN-METHOD-NV-10

Integrated Vegetation Condition Method

ACCREDITED METHOD · Accounting for Nature

Land | Vegetation

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Method Name	Integrated Vegetation Condition Method
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Environmental Asset	Vegetation
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License fees associated with using this Method	Subject to licence fees, please contact Bush Heritage Australia
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Version History

Version	Last updated	Description	Approval
1.0	29 June 2022	Accredited Method	AfN
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Licencing

A Method Licence Agreement must be signed to use this Method for the purpose of developing an Environmental Account for Certification under the Accounting for Nature® Standard. Contact AfN or Bush Heritage Australia for more information.

This licence fee contributes to ongoing maintenance and improvement of this Method by Bush Heritage Australia. Bush Heritage Australia is a leading not-for-profit conservation organisation that protects ecosystems and wildlife across the continent.

Disclaimer

About

Environmental Asset	Native vegetation The Method prioritises the assessment of the condition of the dominant vegetation communities in the Account Area and/or any vegetation communities more likely to be impacted by a particular change in land management. The Method also prioritises the assessment of any Threatened Ecological Communities (TEC) mapped or detected on the property.
Purpose	This Method outlines a process to develop an Environmental Account under the Accounting for Nature® Framework that complies with the Conservation Standards (https://conservationstandards.org/) and will detect long-term change in the condition of native vegetation. It is intended to support a diverse range of land managers to measure and track the condition of native vegetation over time.
Target Audience	All land managers including conservation reserve managers, indigenous managers and farmers, and their funders.
Decisions to inform	To inform and assess land management actions and outcomes over time.

Application

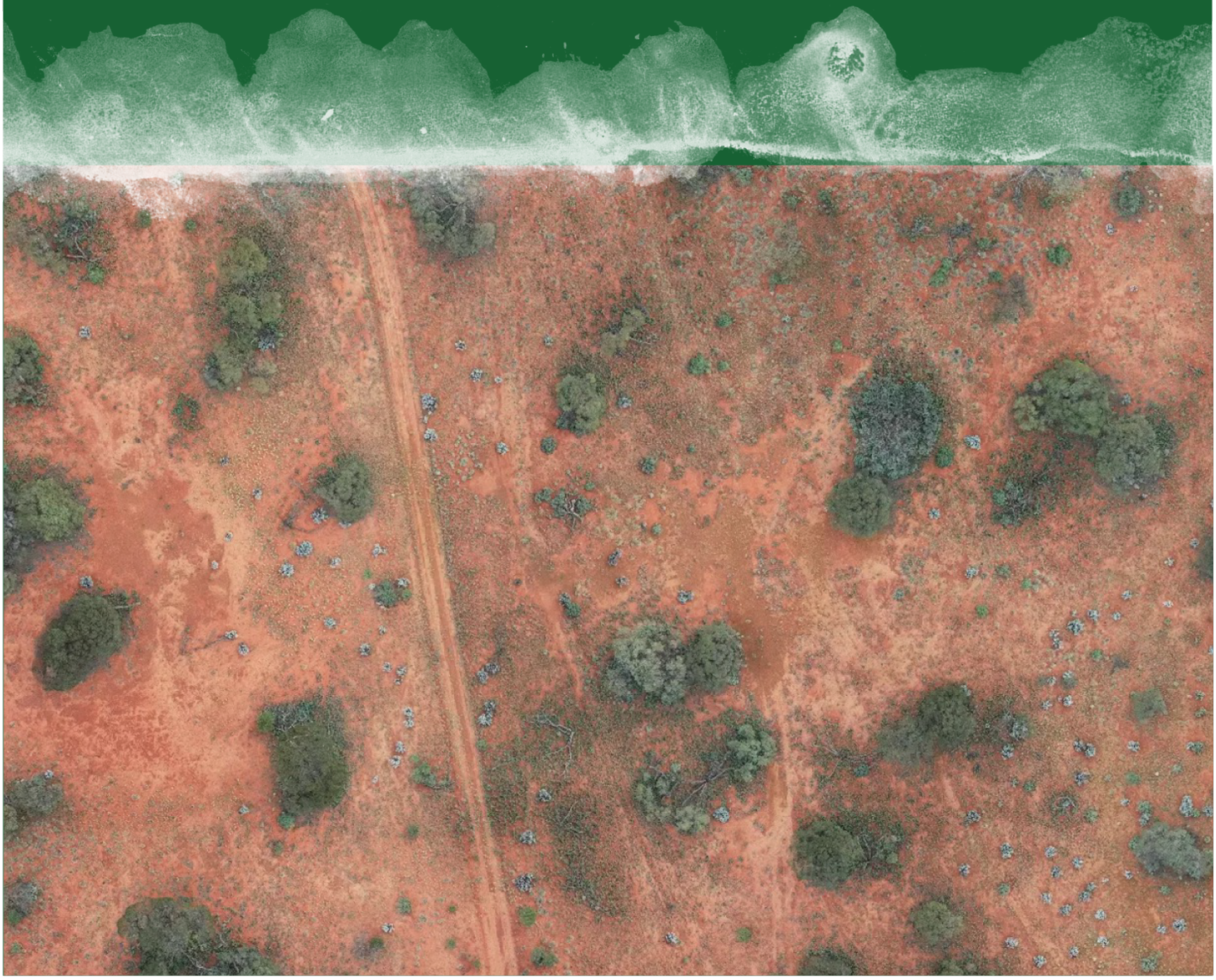
Reporting Period	1-2 years – Econd® can represent condition over 1 or 2 years.
Scale and Size	Whole of Property, ideally suited to larger properties between 2,000 and 2,000,000 hectares, aligned to title boundaries (property-scale) or a portion of a property (project-scale). It is preferable to assess the entire property to detect changes in the condition and extent of all native vegetation (or those areas more likely to be impacted by a particular change in land management) over time. It may also be applicable to develop regional-scale accounts.
Geographical Location	Australia-wide, open canopy vegetation communities such as grasslands, heathlands, and woodlands, including modified vegetation types on farmland. No more than one-third of a property should be comprised of forest or shrubland where dense canopy cover prevents the assessment of shrub and ground layer indicators.
Realm	Land
Biome/Functional Ecosystem Group	The Method is applicable to a range of Ecosystem Functional Groups including Tropical-subtropical forests, Temperate-boreal forests and woodlands, Shrublands and shrubby woodlands, Savannas and grasslands, Deserts and semi-deserts, Polar-alpine, and Intensive land-use systems under the IUCN Global Ecosystem Typology. However, the Method is not suitable in systems comprising dense canopy cover (i.e., areas where high-resolution remote sensing is unable to accurately survey shrub and ground layer indicators) (see Geographic application above).

Snapshot

	Very High Accuracy (95%)	High Accuracy (90%)	Moderate Accuracy (80%)
Stratification	Quality maps of vegetation communities, land systems or land types, combined with a general vegetation condition overlay (e.g., land-use history). If no suitable maps are available then alternatives such as a carbon project stratification map, or a remote sensing-based classification or clustering should be developed.		
Minimum threshold for Stratification Accuracy	>70%*	>65%*	Calculate and report
Sample location	The location of remote sensing sample plots (and on-ground plots within them) shall be randomised within each Assessment unit but with ready access to on-property tracks.		
Sample intensity	≤100 ha, 2 plots >100 to ≤500 ha, 3 plots >500 to ≤5,000 ha, 4 plots >5,000 to ≤20,000 ha, 5 plots >20,000 ha, 6 plots	≤500 ha, 2 plots >500 to ≤5,000 ha, 3 plots >5,000 to ≤20,000 ha, 4 plots >20,000 ha, 5 plots	≤100 ha, 1 plot >100 to ≤500 ha, 2 plots >500 to ≤5,000 ha, 3 plots >5,000 ha, 4 plots
Sample timing	The most appropriate time to survey is during the flowering/fruiting season for most plant species to facilitate species identification. Re-sampling should occur in the same season to ensure consistency in the results over time.		
Indicators and measurement techniques	Full list of indicators in Table 2 as appropriate to the vegetation type. Any exclusions need to be justified in the accompanying Information Statement. High-resolution remote sensing and ecological field measures are used to collect these indicators.	The majority of indicators in Table 2, with indicators A, C, E and G through N compulsory, and indicators B, D, F, O and P optional. Any further exclusions need to be justified in the accompanying Information Statement. High-resolution remote sensing and ecological field measures are used to collect these indicators.	Selected indicators from Table 2, with indicators C, G, H, I, M, and N compulsory, and indicators A, B, D, E, F, J, K, L, O and P optional. Any further exclusions need to be justified in the accompanying Information Statement. High-resolution remote sensing and ecological field measures are used to collect these indicators.
Minimum threshold for remote sensing classification accuracy	>75%	>65%	Calculate and report
Expertise Required	• Remote sensing data collection expert (e.g., drone pilots) • High-resolution remote sensing data analytics expert (e.g., to verify the quality of, and analyse remotely sensed data to generate indicators) • Trained botanist/ecologist or similar to identify vegetation types and plant species		

*using the approach outlined in Step 6. For all Accuracy Levels, it is mandatory to report the stratification accuracy, the remote sensing accuracy, the sampling effort and the list of indicators applied. The Method Authors will review the thresholds with further application of the Method.

Integrated Vegetation Condition Method



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1. Introduction

1.1. Aim and Scope of this Method

This Method has been developed to assess the condition of native vegetation as defined at the Property/Landscape-scale and is most applicable to open canopy vegetation communities such as grasslands, heathlands, and woodlands, including modified vegetation types on farmland. Together, Bush Heritage Australia and Climate Friendly have developed this Method enabling high-resolution remotely sensed data to be integrated with ecological ground observations to accurately and efficiently measure many components of vegetation condition across a wide range of properties and landscapes of Australia. The combination of ground-based observations and remote sensing data enable the assessment of vegetation condition at scales relevant to changes in the ecosystems listed above. High-resolution remote sensing Methods can sample much larger areas than ground-based surveys, making them more suitable and versatile for deriving accurate structural vegetation indicators regardless of property size. For example, remote sensing can be used effectively on large properties (>2000 ha) where the sole reliance on traditional on-ground sampling is less feasible and prohibitively expensive.

The Method builds on the current monitoring and evaluation program that Bush Heritage uses to inform the adaptive management of its reserves (the international Conservation Standards) together with the Accounting for Nature® accredited Bush Heritage Australia – Native Vegetation Assessment Method (AfN-METHOD-NV-07) and integrates elements from carbon farming Methods approved by the Clean Energy Regulator. The Method follows the Accounting for Nature® Standard and is consistent with the System of Environmental-Economic Accounting – Ecosystem accounting (UN 2021). This Method determines the environmental condition (measured using the Econd®) of the native vegetation at the subject property relative to its undegraded (natural or best possible) state: the reference benchmark. The Econd® is an index that ranges between 0 and 100, where 100 describes the condition of a vegetation community reference benchmark.

The application of the Econd® to reserves, carbon projects, and other land holdings will help communicate the health of the native vegetation on these lands and provide valuable feedback for managers. While the Method has been developed with learnings from carbon project monitoring, it can be applied to any property.

1.2. What is an Environmental account?

The Accounting for Nature® Framework is used to produce Certified Environmental Accounts, which are used to underpin credible public or confidential Claims in the market regarding the state of nature. Environmental Accounts are spatially explicit and cover a discrete area of any size, from tens of hectares to millions of hectares.

An Environmental Account is a single registered environmental accounting project that reports on the Condition of one or more Environmental Assets. Environmental Accounts are comprised of individual Environmental Asset Accounts (‘Asset Account’) which individually reflect the Condition of one Environmental Asset as specified by a single accredited Method. The Asset Account(s) must be contained within the Boundary of the Environmental Account, but they each can be a smaller area. The area of the Asset Accounts depends on the Purpose of the Environmental Account and where the Asset exists within the Environmental Account Boundary.

An Environmental Account includes all underlying data and calculations which is summarised into an Information Statement. The Information Statement is a critical document that transparently describes, in non-technical terms, the Purpose of developing an Environmental Account, the rationale for the selection of Environmental Assets and Method(s), an overview of the data collection, analysis and results, disclosure of any limitations and the account Certification status. The Information Statement is Certified by AfN as part of an Environmental Account.

1.3. Record-keeping

Throughout the Method, each step has a designated output box, which describes the key outputs that should be generated for each step, these outputs are summarised into a checklist in Appendix A. The output of each step and a description on how it was generated is required for the Environmental Account audit process and is used to confirm that the Method has been followed correctly. Proponents are therefore required to record and retain each output and provide these in confidence as part of the Environmental Account audit process.

1.4. Glossary of Key Terms

Refer to Appendix B for a Glossary of Key Terms in this Method.

1.5. Overview of Process

Preliminary Step.	Design Environmental Account and identify Asset Account team
Step 1.	Define Asset Account Boundary
Step 2.	Compile existing data and identify sub-assets
Step 3.	Stratify accounting area and develop Data Collection Plan
Step 4.	Indicators and Reference Benchmarks
Step 5.	Data collection and data analysis
Step 6.	Validate Stratification (return to Step 3 if thresholds not met)
Step 7.	Calculate Indicator Condition Scores
Step 8.	Calculate the Econd®

2. Creating an Environmental Asset Account

Preliminary step: Design Environmental Account and identify Asset

Design Environmental Account

Applying an Accounting for Nature® Accredited Method requires that the following steps are first undertaken in accordance with the **Accounting for Nature® Environmental Account Rules (Environmental Account Rules)** and the **Accounting for Nature® Standard ('the Standard')**.

1. The Environmental Account Purpose is defined (refer to Section 3.1 in **Environmental Account Rules**);
2. Environmental Assets are selected according to the Purpose (refer to Section 3.2 in **Environmental Account Rules**);
3. A Method with a scope appropriate to the Purpose are selected for each Environmental Asset (refer to Section 3.3 and 3.4 in **Environmental Account Rules**); and
4. The Environmental Account Boundary has been identified (but may be refined in accordance with Step 1 – Define Asset Account Boundary) (refer to Section 3.3.2 and 3.5.2 in **Environmental Account Rules**);

Some key design considerations specific to this Method are described below.

Purpose:	This Method can be used to support Environmental Accounts where the purpose is to assess the vegetation condition over time and inform management practices for the conservation and improved health of the Sub-assets.
Account Type:	This Method can be used for the following Account Types: *Change over time* – an ongoing assessment of the change of vegetation condition through time. And, in some cases, *Cause of change* – determine how the impacts of management activities change the condition of environmental assets, either at a point in time or through time.

Identify Asset Account team

An important step in designing an Environmental Account is to identify and engage the required experts that will build the Asset Account.

This Method requires the following skills, qualifications and experience for implementation.

- An individual or team, where at least one individual has completed the Accounting for Nature Training Course (such as an Accounting for Nature® Accredited Expert), with the ability to:
  - Synthesise remote sensing and ecological data
  - Conduct stratification accuracy assessments
  - Establish Indicator Condition Scores and Econd®
- High-resolution Remote sensing experts with the ability to:
  - Collect high-resolution remote sensing data (e.g., drone/aerial)
  - Prepare orthomosaics from raw imagery or height models from LiDAR point clouds

    - Establish classification pipelines to calculate Indicator Condition Scores from remote sensing data
    - Verify model accuracy
- Field botanist/ecologist/other suitably qualified professional with the ability to:
    - Identify vegetation species within the Environmental Asset Accounting area
    - Identify vegetation classes within the Accounting Area
    - Determine local reference sites

Output of Preliminary Step

- A description of the Environmental Account Purpose.
- A justification for how and why the Environmental Assets and Methods were selected.
- Maps showing the Environmental Account Boundary.
- A list of people (with relevant qualifications and/or experience) who will be involved in developing the Asset Account.

Step 1. Define Asset Account Boundary

The Asset Account Boundary is defined by the extent of the lands under management, usually a whole property but may be a defined management area (such as a carbon project area).

Importantly, when designing the Asset Account Boundary, Threatened ecological communities (TECs) are considered material, and where mapped or detected on the property are to be included in the Asset Account Boundary and appropriately sampled.

Non-TEC Sub-assets comprising less than 1% of the total account area may be considered immaterial, although any Sub-asset excluded will need to be justified in the Information Statement. Any areas deemed immaterial should be excluded from the area-weighted condition calculations.

A description of the Asset Account Boundary, including its location and size, should be presented and area should be calculated. A map depicting the Asset Account Boundary and its context is to be included.

Output of Step 1

- A description of the accounting area including **location** and **size**
- A table describing the **purpose** and **scope** of the account including a statement of **materiality.**

Step 2. Compile existing data and identify Sub-assets

There are a range of vegetation classification maps across different jurisdictions. There are also additional ways vegetation can be classified using remote sensing. These mapping options have different granularity, accuracy, and precision. There is no one-size-fits-all approach available that can be applied nationally that would not compromise the accuracy of resulting individual Environmental Asset Accounts.

A vegetation map is required in order to identify the Sub-assets, which then facilitates the process of stratifying the Asset Account area into Assessment Units. As part of identifying the Sub-assets, any TECs will also need to be identified (i.e., communities listed as threatened, endangered or critically endangered under State or Territory and/or Commonwealth legislation)

2.1. Existing vegetation mapping

The Vegetation Sub-assets can be identified using suitably granular vegetation mapping information of the account area that meet suitable statistical thresholds.

Available vegetation maps that cover the account area should be considered in the first instance. These maps include (where applicable) State/Territory-sourced maps (e.g., vegetation, land systems or land type). Note: the National Vegetation Information System map is often not sufficiently accurate at the property scale.

Determine the number and names of the Vegetation Sub-assets on the property by grouping (if possible) any similar mapping units. A Vegetation Sub-asset may be an amalgamation of two or more vegetation types that have strong structural and/or compositional similarities (e.g., both vegetation classes are grassy woodlands but with different dominant species or a slightly different understorey composition). These Vegetation Sub-assets may align with the descriptions of vegetation types from an applicable state-wide vegetation classification (e.g., Regional Ecosystems in Qld, Plant Community Types in NSW, Ecological Vegetation Classes in Vic).

2.2. Vegetation mapping unavailable (or unsuitable)

In circumstances where vegetation mapping is unavailable or the mapping is deemed unsuitable (e.g., small-scale maps) carbon project stratification maps, remote sensing-based classification or clustering, or alternative mapping expected to correlate with vegetation communities can be considered. Below are sources of information that could assist in stratifying an Asset Account area in the absence of accurate vegetation mapping.

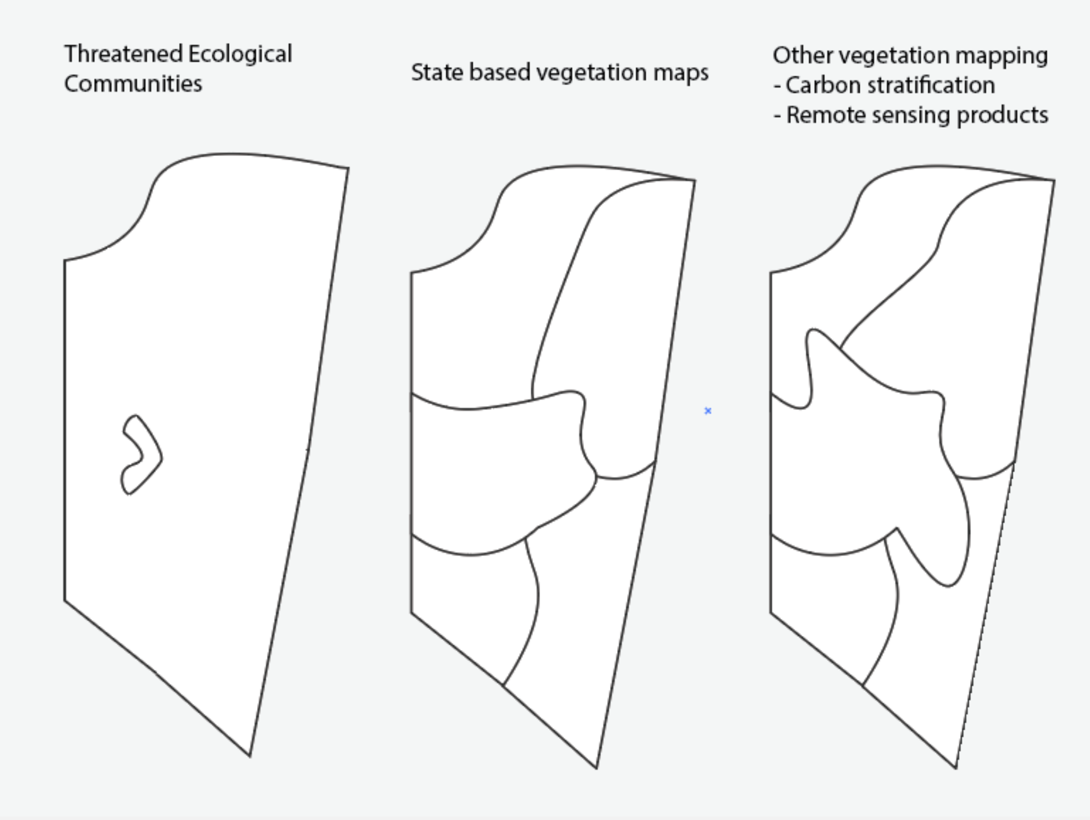
- Carbon Project Stratification
    - Forest cover in previous 10 years (Forest cover defined as canopy cover ≥20% and ≥2-metres tall)
    - Areas of natural forest potential, i.e., areas that have not been forest/woodland for at least the previous 10 years
    - Other (e.g., areas not eligible to generate carbon under current HIR Method, infrastructure, water)
    - Areas of environmental or plantation plantings (e.g., shelterbelt and block plantings)
- Satellite Remote Sensing
    - Spectrally visible soil types likely to correspond to vegetation communities (e.g., black soils, rocky, red soils, aeolian sand, alluvial/riparian flood plains, etc.)
    - Water bodies/Wetlands
    - Infrastructure

- Other mapping likely to correlate to vegetation communities
    - Alluvial/riparian soils defined as 100-year flood line
    - Canopy cover mapping, which can be separated into tiers of canopy cover (e.g., corresponding to woodland, open forest, etc.)

Note that the use of alternative sources of mapping for stratification is likely to constitute an un-labelled stratification (i.e. where vegetation is unable to be assigned at generation), where the accuracy assessment would need to follow the process outlined in Appendix C.

Output of Step 2

- A vegetation map or GIS layer of the accounting area showing Sub-assets, including any TECs.
- A map of the accounting area stratified into Assessment Units, including information about management activities/history or TEC information used to create the Assessment Units (if applicable).



Step 3. Stratify the accounting area and develop a Data Collection Plan

3.1 Stratifying the accounting area

A stratification is undertaken over the Accounting Area to create a map of Assessment Units using the map of Sub-assets developed in section 2. This map will be validated with subsequent on-ground sampling.

The stratification process shall:

1. Ensure that TECs are treated as Sub-assets in their own right. Therefore, any Sub-assets that are a mix of TEC and non-TEC vegetation types need to be split. Note: two or more TECs can be grouped into a single Sub-asset if they share strong structural and/or compositional similarities.
2. Consider past and current land management activities. Split any Sub-assets that has more than one broad condition states. For example, if there are areas of relatively intact native vegetation and areas of degraded or cleared native vegetation, then there will be two Assessment Units representing that Sub-asset. If management actions are consistent across the property, then the Sub-assets equate to the Assessment Units. Each Assessment Unit shall be relatively homogenous, but a unit does not necessarily have to be a single geographic area (i.e., it may be split and occur in different sections of the property so long as it has the same underlying Sub-asset and land-use/management/broad condition state). Some examples of management practices that affect condition (and therefore the assignment of Assessment Units) are:
    - tree clearing
    - conversion to introduced pasture or cropping,
    - loss of understorey through stock grazing,
    - forestry,
    - remnant vegetation managed for carbon and/or conservation,
    - retained regrowth vegetation managed for carbon and/or conservation,
    - extensive infestations of invasive plant species; and
    - regeneration/restoration.
3. Conduct on-ground ecological surveys (Step 5.2) and validate whether the stratification adequately represent Sub-assets (Step 6).
4. Re-assess the suitability of Assessment Unit maps on the individual property after completion of the validation process and revise if needed. When found to be suitable on a specific property, then utilize that approach in future surveys.

If the field validation of the stratification meets the required stratification quality assessment (described in Step 6), then additional re-stratification of Assessment units is not required. If it does not, the stratification shall be revised. Upon revision, if the distribution of any existing field samples does not meet the sampling criteria, supplementary field samples may be required. If supplementary field collection is necessary, proponents should endeavour to undertake this sampling in the same year to ensure comparability with the remaining assessment data.

3.1.1 Stratifying spatially patchy vegetation types

In spatially patchy vegetation types such as groved or banded Mulga, further consideration of the stratification and sampling approach is necessary. It is appropriate to either stratify groves from inter-grove areas into two Sub-assets (while considering the appropriate grove: inter-grove ratio at the landscape scale), or to group these features as a single Sub-asset while also increasing sampling intensity such that both grove and inter-grove areas are sufficiently sampled.

3.2 Identify Reference sites (if using Local Benchmark, refer to Step 4)

Local reference sites shall be located on or in close proximity to the property. The stratification process will indicate the range of Sub-assets for which reference sites are required. The property land use history layer may reveal Assessment Units that potentially contain areas that are in reference condition. For example, Assessment Units that have no livestock and/or have been managed primarily for conservation purposes could make excellent candidate areas to look for reference sites. See Table 3 for local reference site selection criteria.

A few prospective sites/areas could be identified for each Sub-asset prior to a site visit to provide options in case some fail to meet the standard and/or to select the best condition sites out of all the options. Each site is assessed against the criteria listed in Table 3 (on page 22). If the sites for Sub-assets on the property generally fail to meet the standards, then alternative sites off the property can be considered. If all options are exhausted and no (or too few) sites meet the standard, relevant indicators may be adjusted to reflect reference condition (i.e., weed cover reduced to zero or all tree canopies rated in the top health category). This is based on expert opinion and may not be appropriate for all indicators - refer to section 4.2 for more details.

3.3. Document the Data Collection Plan

The data collection plan entails the sampling approach, site selection, site establishment, and timing of surveys.

3.3.1. Sampling approach (Remote sensing and on-ground)

Assessment sites are assigned to each Assessment Unit according to the guidelines listed below in Table 1. Remote sensing plots cover a minimum of 5 hectares, and the corresponding on-ground plots for each site (1 central plot and 2 additional plots) are located within this area. The assessment sites are permanent monitoring sites that characterise each Assessment Unit.

Table 1: Overview of how to select and establish assessment sites within each Assessment Unit

Sample	Implementation		
Number of Assessment sites per Assessment unit	**95% Accuracy**		
	Assessment Unit area	**Minimum number of remote sensing plots per Assessment Unit**	**Number of on-ground samples per remote sensing plot**
	≤100 ha	2	1 central plot and 2 additional plots
	>100 to ≤500 ha	3	
	>500 to ≤5,000 ha	4	
	>5,000 to ≤20,000 ha	5	
	>20,000 ha	6	
	90% Accuracy		
	Assessment Unit area	**Minimum number of remote sensing plots per Assessment Unit**	**Number of on-ground samples per remote sensing plot**
	≤100 ha	2	1 central plot and 2 additional plots
	≤500 ha	2	
	>500 to ≤5,000 ha	3	
	>5,000 to ≤20,000 ha	4	
	>20,000 ha	5	

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<tr><th>Sample</th><th>Implementation</th></tr>
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80% Accuracy
<table>
<tr><th>Assessment Unit area</th><th>Minimum number of remote sensing plots per Assessment Unit</th><th>Number of on-ground samples per remote sensing plot</th></tr>
<tr><td>≤100 ha</td><td>1</td><td rowspan="4">1 central plot</td></tr>
<tr><td>>100 to ≤500 ha</td><td>2</td></tr>
<tr><td>>500 to ≤5,000 ha</td><td>3</td></tr>
<tr><td>>5,000 ha</td><td>4</td></tr>
</table>
Note: For 95% and 90% Accuracy Accounts, where Assessment Units describe native vegetation that has been highly modified (evidenced by land management data), the number of plots can be reduced. Management actions that may justify reduced sampling include cropping, cultivation, and pasture intensification using exotic species and fertiliser. In these scenarios, condition scores are likely to be close to zero, and relatively homogeneous across the assessment unit. Such Assessment Units can be sampled at the level recommended for the next Accuracy Level down using Table 1.
For example, 95% Accuracy accounts could sample highly modified areas at the sampling intensity required for 90% Accuracy. For 80% Accuracy accounts, no reduction in sampling intensity is permitted. In addition, where the proponent could conservatively assign an Assessment Unit a condition score of 0 (e.g., a monoculture crop), the assessment unit does not need to be sampled at all. Any reduction in sampling intensity needs to be justified in the Information Statement.
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3.3.2. Site Selection

The location of remote sensing plots (and on-ground plots within them) shall be randomised within each Assessment unit but with ready access to on-property tracks (e.g., within a 200 m buffer either side of a property track). This could be achieved using a specific randomisation tool within a GIS or through a similar unbiased process. Where possible, plots should not be set up near infrastructure such as buildings, dams, or busy tracks/roads. Plots must not be located in the transition zone between two or more vegetation types (e.g., ecotones).

On-ground sampling plots should sit within the remote sensing plots. The only exception is where on-ground access is too difficult or dangerous (e.g., the terrain is too rough to cross on foot). In these circumstances, the on-ground plots shall be situated as close as possible to the remote sensing plot and within the same Assessment Unit.

Where an Assessment unit is split into multiple non-contiguous areas, the assessment sites shall be split proportionally to the spatial extent of these sections in order to achieve a spread of sites. There are some exceptions such as circumstances where one (or more) section has poor/no access. The minimum 5-hectare polygon should be contained entirely within the Assessment Unit, which may necessitate the selection of larger patches and/or customisation of plot shapes.

Local reference sites shall match the same vegetation class and occur within the same landscape unit and climatic area. Expert opinion will be used, considering set criteria (Table 3) and described in the Account Information Statement.

3.3.2. Site Establishment

The corners of the remotely sensed plots will be defined using Global Positioning System (GPS). The on-ground plots will also be defined using GPS (e.g., to mark the corners/centroid of a quadrat). The on-ground plots may also be permanently marked with star pickets (or similar) to assist with relocating the transects/quadrats on subsequent visits. Where markers are not used, the plot must be within 2 metres of the original GPS point. The assessment site information (including position, vegetation class, geology etc) shall be stored in a database.

3.3.3. Timing of the Surveys

Where there are no local reference sites used, the property will be re-sampled, where possible, in a similar season to ensure consistency in the results over time. The most appropriate time to survey can vary considerably, but in general vegetation surveys are best done during the flowering/fruiting season for most plant species to facilitate species identification. Ensure that annual species get captured as well as the perennial species and avoid surveys in particularly dry times of the year as even some perennial species will die down during these times. The most appropriate season to sample in southern temperate Australia tends to be in spring (September to November), whereas in tropical Australia, the most appropriate time to sample are the months following the end of the wet season. Ideally the surveys shall be conducted in the same month in each sampling year, but some flexibility is permitted in case the current conditions are exceptional (e.g., wintery conditions extend into September) or logistical constraints impact survey plans.

The timing of sampling is less relevant when using local or dynamic benchmarks. However, the same constraints on species identification apply and some herbaceous species will be difficult to detect and/or identify during dry and/or hot conditions.

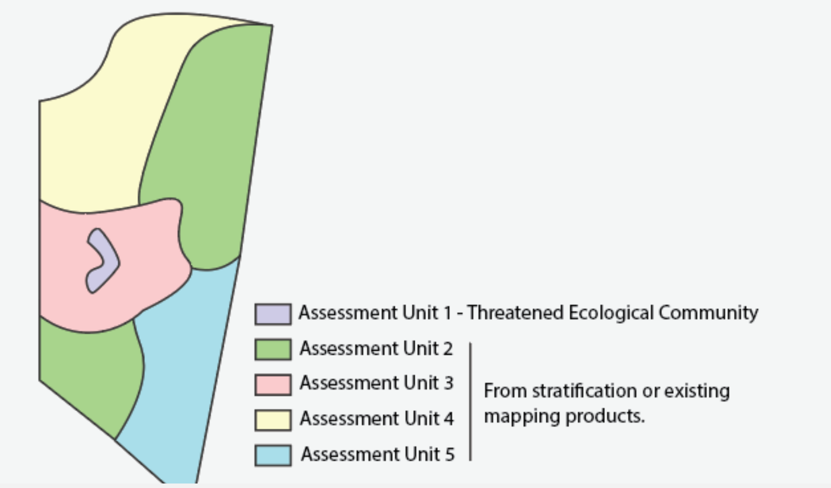
The timing of remote sensed and on-ground data capture should occur within the shortest window possible, but due to logistical practicalities, may be decoupled. The sampling times must still be within six months, or the same season in the following year (e.g., early dry season of one year used in conjunction with early dry season of the following year). The time of year that the surveys were undertaken and any significant difference in the timing of the on-ground and remote sensing data collection needs to be justified in the Information Statement (refer to the Accounting for Nature® Standard - Data Collection Schedule).

3.4. Register account

Once the Asset Account has been stratified into Assessment Units, a Data Collection Plan has been generated and assessment site locations have been allocated, register the Account with Accounting for Nature.

Output of Step 3

- A map of the property stratified into Assessment Units and a table of the management activities and/or history (e.g., clearing and/or grazing history) or TEC information used to split Sub-assets (if applicable).
- A Data Collection Plan
- Account registered with Accounting for Nature.



Step 4. Indicators and Reference Benchmarks

4.1 Indicators

The Guidelines for Developing Methods to Assess the Condition of Native Vegetation (AfN, 2022) established three indicator themes used to describe native vegetation condition. The indicator themes for native vegetation must represent the following three classes:

- the **extent** of vegetation (the area and proportion of Sub-assets in the landscape),
- its **configuration** (how the Sub-assets are distributed across the landscape), and
- its **composition** (such as structure and species richness of Sub-assets).

Together these three components provide the foundation for indicators required for native vegetation condition Methods consistent with this Guideline. Accounting for Nature® Accredited Vegetation Methods require indicators within each of these three themes. These are interpreted as follows:

- **Extent:** The extent of vegetation is determined for each Assessment Unit within the accounting area. It may be necessary to refer to a pre-1750 vegetation map to determine the area of a Sub-asset where the vegetation has been significantly modified. Extent is used directly in the Econd® calculations to inform area-weighted averages.
- **Configuration:** The configuration of native vegetation relates to its connectivity, context and patch size within the local landscape (i.e., in the vicinity of the assessment site). This Method uses the context of each assessment site as a measure of the configuration. Configuration is the percent of remnant vegetation retained within a 1-km radius of each assessment site. Remnant vegetation is defined as any area mapped as a native vegetation community, though verification on-ground or from aerial photography is necessary to exclude areas that have been more recently cleared or are now highly modified (e.g., introduced pastures). The benchmark for Configuration will be taken as the pre- 1750 extent of vegetation within 1 km of each assessment site, which is typically 100 %.
- **Composition:** The composition of native vegetation relates to its structure and the assemblage of species. In this Method, composition across the whole property will focus on species diversity attributes measured on-ground within quadrats, and vegetation form and cover elements measured with high-resolution remote sensing. These indicator classes are listed below (Table 2), and are further detailed in Table 4.

Table 2: Indicator classes and indicators

<table>
<tr><th>Indicator class</th><th colspan="3">Indicator</th></tr>
<tr><td>Extent</td><td colspan="3">The extent of each Assessment Unit.</td></tr>
<tr><td>Configuration</td><td colspan="3">The proportion of native vegetation remaining within a 1-km radius around each assessment site.</td></tr>
<tr><td rowspan="2">Composition</td><td>Very high (95%) Accuracy</td><td>High (90%) Accuracy</td><td>Moderate (80%) Accuracy</td></tr>
<tr><td>A) Native tree canopy height
B) Native tree canopy health score
C) Native tree canopy cover
D) Native tree size structure
E) Native species count (richness) for tree canopy and shrub layer species
F) Native tree species recruitment
G) Native shrub cover
H) Non-native shrub and tree cover
I) Native herbaceous (photosynthetic) cover
J) Native species count for herbaceous species – graminoids
K) Native species count for herbaceous species – forbs
L) Native species count for herbaceous species – other species
M) Non-native herbaceous cover
N) Organic litter i.e., non-photosynthetic ground cover (brown or dead)
O) Cryptogam cover (may exclude algae crust if no reference condition is available)
P) Coarse woody debris</td><td>A) Native tree canopy height
C) Native tree canopy cover
E) Native species count (richness) for tree canopy and shrub layer species
G) Native shrub cover
H) Non-native shrub and tree cover
I) Native herbaceous (photosynthetic) cover
J) Native species count for herbaceous species – graminoids
K) Native species count for herbaceous species – forbs
L) Native species count for herbaceous species – other species
M) Non-native herbaceous cover
N) Organic litter i.e., non-photosynthetic ground cover (brown or dead)

Indicators B, D, F, O and P optional for High (90%) Accuracy.</td><td>C) Native tree canopy cover
G) Native shrub cover
H) Non-native shrub and tree cover
I) Native herbaceous (photosynthetic) cover
M) Non-native herbaceous cover
N) Organic litter i.e., non-photosynthetic ground cover (brown or dead)

Indicators A, B, D, E, F, J, K, L, O and P optional for Moderate (80%) Accuracy.</td></tr>
</table>

Not all the composition indicators listed in Table 2 will be applicable to all vegetation types (e.g., trees and tall shrubs in native grasslands). In these circumstances, the score will be recorded as 'NA' (i.e., 'not applicable') and will be ignored in the Econd® calculation.

4.2. Reference Benchmarks

The Accounting for Nature® Standard refers to the Reference Benchmark ('Benchmark') as the 'undegraded' state of each native vegetation type. As such, Benchmark areas would not have experienced any negative impacts as a result of exogenous disturbance (not part of the post-industrial disturbance regime e.g., stock grazing or vegetation clearing), edge effects, invasive weeds, or altered regimes of flood or fire. This Method broadly follows the options set out in the Accounting for Nature® Method Rules, with four approaches available for setting reference Benchmarks. A combination of these approaches may also be appropriate. To ensure full transparency, the selection and source of the benchmarks used in an Account must be detailed in the accompanying Information Statement.

Given the impact of reference benchmarks on indicator condition scores, the reference benchmark approach should remain consistent for the life of the account.

4.2.1. Local Benchmark – Observations made at local reference condition sites

Typically, local benchmarks will be established using data collected at local 'best on offer' reference sites (i.e., areas of vegetation undegraded by human activity). These sites are assessed using the same methodology as the assessment sites in the account. The reference sites may fall within the Accounting Area or be located nearby. These sites are selected based on an on-ground assessment by an ecologist. Some indicators can be adjusted to reflect assumed reference condition (e.g., non-native herbaceous cover could be adjusted to zero and tree health scores could be set to the highest level, as appropriate).

The selection of local reference sites should consider distance from waterpoints, fencing, roads, conservation status, clearing history, stock density (preferably none) and the prevalence of weeds and pests. Local reference sites should comply with the criteria outlined in Table 3 and those outlined in section 5.3(d) of the Accounting for Nature® Standard.

Table 3: Local reference site selection criteria

Local reference site selection criteria	
The criteria that are applied by an expert ecologist to determine a local benchmark site	• Same vegetation class as found on the property. • Represent undisturbed or unimpacted areas (i.e., no recent major management changes, and limited evidence of historical or recent impacts such as cleared, cultivated, overgrazed, fertilised, fire, erosion, dieback, flooding, invasive species or any other asset-specific negative impact) • No or low stock grazing pressure over the last 20 years. • Appropriate management of invasive plants + feral and pest animals. • Located within the same landscape unit and climatic area and within the same IBRA sub-region (or region if none apply) • Can be legally accessed for sampling.

If it is feasible to do so, sites should be sampled during both high and low rainfall years in the first few years after an account is established to provide benchmark data from a range of climatic conditions.

4.2.2. Published Benchmarks – Based on existing records

Some States/Territories have published vegetation condition benchmark documents that apply to that region's vegetation community mapping (refer to Appendix D for the current publication in each State and Territory). The existing State-defined benchmarks can be used to determine the most applicable Reference Benchmark for the purposes of this Method. The techniques used to collect the on-ground ecological data (particularly species data) broadly follow those described for the state-based condition assessment frameworks. In States and Territories where there is no condition assessment framework, other sources of data could be utilised to create benchmarks. These alternative sources could be used to obtain equivalent or more local benchmarks from respected sources such as State government (e.g. Herbarium, and vegetation ecologists in the Environment or Agriculture departments), regional NRM bodies or local experts.

These benchmarks have been developed with consideration of ground-based observations but without consideration of observations made using high-resolution remote sensing. This Method enables the translation of published benchmarks established with ground-based Methods to indicators derived from a combination of high-resolution remote sensing and ground-based Methods (See Translated Benchmark below).

4.2.3 Modelled Benchmark - A model that estimates the undegraded state of the environmental asset

The Method allows the undegraded state of a native vegetation to be modelled. When models are used, the choice of model and assumptions made need to be included in the Information Statement.

4.2.4 Expert Elicited Benchmark – Expert opinion on the undegraded condition of the environmental asset

Where it is not possible to establish Local Benchmarks and Published or Modelled benchmarks are not available, expert opinion may be used to determine Reference Benchmarks. Where expert opinion is used it can be sourced from an individual or a panel who are experienced and familiar with the chosen assets and Sub-assets; and able to demonstrate their expertise (i.e., publications, field experience etc). The experts' opinion should be informed by any available data and endorsed through an independent review (if possible).

4.3. Further reference benchmark options

4.3.1. Static vs Dynamic Reference Benchmark

Static Reference Benchmarks are a single value (or range) that represent the undegraded state of an indicator. Dynamic Reference Benchmarks however are designed to represent the natural variation in the undegraded state of an indicator. The above four approaches can either be static or dynamic. In particular, Local Reference Sites and Models are the most common application of Dynamic Benchmarks.

Dynamic Benchmarks can be developed using a model that considers environmental variables (e.g., rainfall, temperature, or sub-surface moisture) to scale static indicators established using the Local, Published, Modelled and Expert Elicited benchmarks. This may not be necessary for all indicators, and is likely to be most relevant for indicators responsive to seasonal impacts such as the influence of rainfall on ground cover. The process followed to develop a dynamic Reference Benchmark needs to be detailed within the Account's Information Statement, and must adhere to the Criteria in Section 4.1.2 of the **Accounting for Nature® Standard**.

4.3.2 Translated benchmarks

The application of remote-sensing surveys, validated with annotated imagery, facilitates rapid and accurate data collection, but this approach calls into question the use of Published Benchmarks, which have generally been derived from ecological field surveys. In some situations, the remote measurement might directly relate to ground measurements, for example, percentage tree cover measured with remote sensing might relate directly to tree cover measured from the ground. In this case, the high-resolution remotely sensed data could be compared to published reference benchmarks directly. In most situations, however, the metrics used for a given attribute will not be directly comparable. While an exact alignment will not always be possible, there is scope for translating ground-based reference benchmarks to measures similar to those collected from remote sensing (Appendix F). For example, tree size could be assessed with remote sensing surveys of crown area and tree height, which may be challenging to link to ground surveyed Diameter at Breast Height (DBH) data. These situations may require the development of Translated benchmarks, and/or Expert Elicited benchmarks.

Output of Step 4

- List the indicators to be measured for each Sub-asset.
- Decide on the intended reference benchmark approach.

Step 5. Data collection and data analysis

The below steps apply to each assessment site.

5.1 Determine the Sub-asset and information as relevant to reference benchmark approach

The Sub-asset at each assessment site will be determined by a qualified ecologist (or other suitably trained expert), and later used to verify the stratification accuracy (see section 6). The ecologist will also decide if a site represents a suitable Local Reference site for the applicable Sub-asset based on the criteria set out in Step 4. Fine-scale vegetation classes (e.g., REs, EVCs PCTs) will also need to be identified if Published Benchmarks are being used.

5.2 Selection of data sources for indicators

Table 4 details the data source options for each Indicator. Where the high-resolution remote sensing option is the recommended data source in Table 4, it should be used except in situations where the selected remote sensing technique cannot be practically applied (e.g., airborne lidar under more dense tree canopies). In these situations, alternatives including those detailed in Table 4, or equivalent field-based remote sensing methods (which could include traditional field techniques or alternate technologies such as TLS), can be applied. When high-resolution remote sensing options are provided as the Alternative data source, they may be used in place of the Recommended quadrat approach if reported remote sensing accuracy and methodologies allow.

The following sections detail the procedures for each of the on-ground data collection, and remote-sensed data collection.

Table 4: Recommended source and measures of data collected for each indicator at each assessment site.

Indicator	Data source options
A) Native tree canopy height (metres)	***Recommended data source*** High-resolution remote sensing (mean or median value across remote sensing plot)
B) Native tree canopy health score (%)	Quadrat – one 0.1 ha (for sparsely wooded areas) OR Quadrat – one 0.05 ha (for more densely wooded areas) (mean score per quadrat)
C) Native tree canopy cover (%)	High-resolution remote sensing (percent cover across remotely sensed plot)
D) Native tree size structure (density by size class, or height variability)	***Recommended data source*** High-resolution remote sensing (Density by size class of remotely sensed tree cover) ***Alternative data source*** Quadrat – one 0.05 ha in more densely wooded areas (field measure of number of stems estimated to be ≥100 mm diameter OR stem diameter(s) as specified by State-based vegetation condition assessment for native tree size structure) OR Quadrat – one 0.1 ha in sparsely wooded areas (number of mature trees OR 'large' trees per ha)

Indicator	Data source options
E) Native species count (richness) for tree canopy and shrub layer species (number)	Quadrat – one 0.05 ha* (field measure of number of native shrub species) (* 0.04 ha in NSW if using BAM published benchmarks) AND (if required) Quadrat – one 0.5 ha (field measure of number of native tree species in addition to those already identified in 0.05 ha quadrat) (cumulative count in the quadrat)
F) Native tree species recruitment	***Recommended data source*** High-resolution remote sensing combined with Field measurements The remotely sensed cover estimation of the shrub layer is adjusted using the percentage of immature tree cover (i.e., tree species ≤ to height of tallest shrub) and native and non-native shrub cover from on-ground survey; Quadrat – three x 0.05 ha (field measure of the cover of immature tree species) (percent cover across remotely sensed plot) ***Alternative data source*** Field measurement – number of stems of immature tree species (i.e., individuals ≤ to height of tallest shrub) (number of immature trees per ha)
G) Native shrub cover (%)	***Recommended data source*** High-resolution remote sensing combined with Field measurements The remotely sensed cover estimation of the shrub layer is adjusted using the percentage of native and non-native shrub cover and immature tree cover from on-ground survey; Quadrat – three x 0.05 ha (field measure of the cover of native shrub species) (percent cover across remotely sensed plot) ***Alternative data source*** Quadrat – three x 0.05 ha (field measure of the cover of native shrub species) where shrub percent cover cannot be accurately assessed using high-resolution remote sensing. (mean percent cover)
H) Non-native shrub and tree cover (%)	As per Indicator (G) but for non-native shrubs + High-resolution remote sensing (non-native tree cover)

Indicator	Data source options
I) Native herbaceous (photosynthetic) cover (%)	***Recommended data source*** High-resolution remote sensing combined with Field measurements The remotely sensed cover estimation of the herbaceous ground layer is adjusted using on-ground survey data to remove the average organic litter portion or portions attributable to cryptogams (see (O) below), and the percentage of native and non-native herb cover; Quadrats - nine x 1m^2 per remote sensing plot (field measure of the cover of native herbaceous species) (percent cover across remote sensing plot) ***Alternative data source*** Quadrats – nine x 1m^2 (field measure of the cover of native herbaceous species) where herbaceous cover cannot be accurately assessed using high-resolution remote sensing. (mean percent cover across quadrats)
J) Native species richness count for herbaceous species – graminoids (number) K) Native species richness count for herbaceous species – forbs (number) L) Native species richness count for herbaceous species – other species (number) NOTE: the three species groupings suggested above may be varied if using a State-based assessment procedure that specifies slightly different groupings (e.g., 2 groups instead of 3 or different groupings)	Quadrat – one 0.05 ha* (field measure of number of native species for each group) (* 0.04 ha in NSW if using BAM published benchmarks) (cumulative species count for each group in the quadrat)
M) Non-native herbaceous cover (%)	High-resolution remote sensing combined with Field measurements As per Indicator (I) but for non-native herbaceous species (percent cover across remote sensing plot) OR (mean percent cover across quadrats)
N) Organic litter i.e., non-photosynthetic ground cover (brown or dead) (%)	***Recommended data source*** High-resolution remote sensing of organic litter cover (percent cover across remote sensing plot) ***Alternative data source*** High-resolution remote sensing and combined with Field measurements The remotely sensed cover estimation of organic litter ground cover can be derived from the herbaceous plant cover measurement using the average percentage of cryptogams, organic litter ground cover, herb cover and prostrate shrub cover collected from on-ground surveys - see Indicator (I). (percent cover across remote sensing plot) OR (mean percent cover across quadrats)

Indicator	Data source options
O) Cryptogam cover (%) (bryophytes, lichens as well as algal crust, if applicable)	***Recommended data source*** High-resolution remote sensing combined with Field measurements The remotely sensed cover estimation of cryptogams is derived from the herbaceous plant cover measurement using the average percent cover of cryptogams to organic litter material to herb cover collected from on-ground surveys - see Indicator (I). (percent cover across remote sensing plot) OR (mean percent cover across quadrats) ***Alternative data source*** High-resolution remote sensing of Cryptogam cover (percent cover across remote sensing plot)
P) Coarse woody debris	***Recommended data source*** High-resolution remote sensing (percent cover of coarse woody debris (≥100 mm diameter) across remote sensing plot) ***Alternative data source*** Quadrat – 0.1 ha; measure the length of fallen timber with stems estimated to be ≥100 mm diameter (m per ha) or diameter as specified in State-based vegetation condition assessment procedure for coarse woody debris (metres of coarse woody debris (estimated to be ≥100 mm diameter) per ha)

5.3. Ground-based data collection

Below are the approved field methodologies for this Method. All attempts must be made to adhere to these measurement protocols and any deviations must be documented and justified in the Information Statement.

All on-ground sampling plots are located within the boundary of the associated remote sensed plot (at least 5 ha). The locations of the on-ground survey plots are recorded using an accurate GPS so that sites can be relocated for re-assessment in following years. The plots can also be marked on the ground using (for example) a star picket.

For each remote sensed survey area there are three plots where on-ground data are collected. The centre of the remote sensing plot (centre on-ground plot) is where most data are collected, and two additional on-ground plots where data are collected relating to a few indicators. Species composition, coarse woody debris (in dense canopy) and tree health data are only collected at the centre plot (Appendix G). Cover estimates are collected at all three plots. An example layout using circular and rectangular quadrats is provided below (Figure 1). The two additional plots are chosen at random while walking to and from the central plot but must be at least 50 metres from the middle of the central plot to avoid any overlap of the shrub quadrats.

The area of the quadrat to be surveyed for each indicator is stipulated in this Method, however the quadrat shape is not stipulated (i.e., the quadrats can be a square, rectangular, or circular covering the exact same area) – see Table 5 for detailed information.

Where an account relies on Published benchmarks, then the area of the quadrat(s) for determining species richness should match the area of the quadrat specified under that particular State's/Territory's vegetation condition assessment methodology (Appendix D). The same condition does not apply for cover-based indicators. For these indicators the area surveyed will follow the specifications outlined in this Method (which match or exceed those outlined in State/Territory methodologies).

The on-ground surveys collect information on all indicators including:

- vegetation species richness in all strata;
- the cover of native and non-native species in each vegetation strata (i.e., ground, shrub and canopy layers, where they exist);
- the cover of immature tree species (where applicable) in the shrub stratum;
- the cover of coarse woody debris and litter (only under dense canopy cover);
- the cover of cryptogams in the ground layer;
- the health and density of tree species in the canopy and sub-canopy layers;
- If applicable, the height cut-off between the herbaceous ground layer and shrub layer (measured as the average height of the foliage of the tallest herbaceous species in the ground layer) to inform ground layer and shrub classifications using high-resolution remote sensing data and
- If applicable, the height cut-off between the canopy and shrub layer (estimated as the average height of the tallest shrub species) to inform tree and shrub classifications using high-resolution remote sensing data.

A **shrub species** is defined as a woody perennial plant, multi-stemmed at the base (or within 750 mm from ground level) and less than 6 m tall when fully mature.

A **tree species** is defined as a woody perennial plant usually with a distinct trunk and usually more than 6 m tall when fully mature. Mallee trees are also included as tree species and are defined as primarily Eucalyptus species with multiple stems arising from a lignotuber. Therefore, the tree health indicator may include small tree species (often described as 'tall shrubs') if they fit the above description. Other indicators such as native tree size structure or tree recruitment may include small tree species, but this decision largely depends on whether the benchmark specifies a particular species or group of species. Some published benchmarks provide a tree density for

Eucalyptus and/or allied genera (*Corymbia* and *Angophora*) as well as one for non-Eucalypt tree species. In these cases, there are several options such as selecting one group over the other or calculating the average score of the two groups.

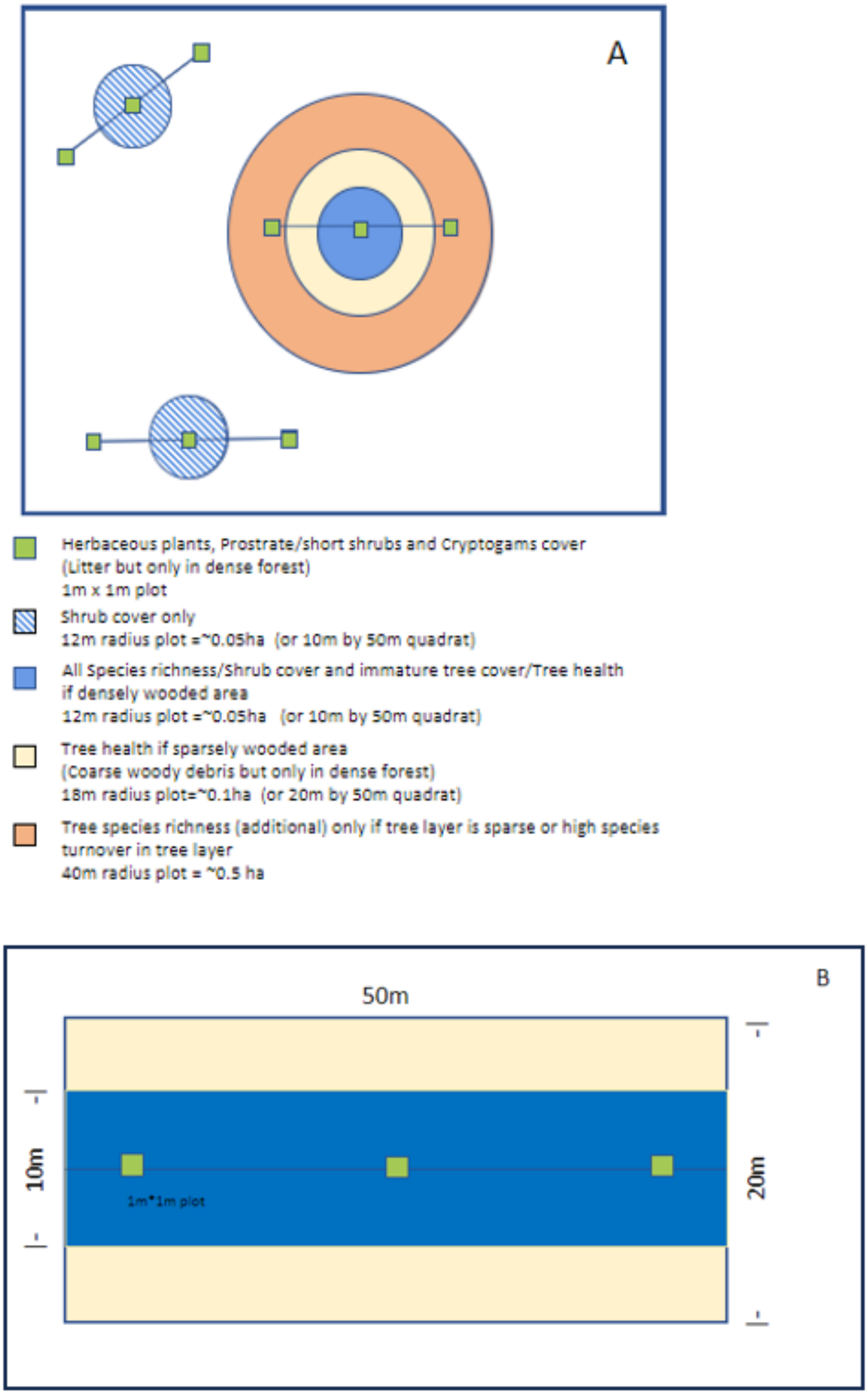


Figure 1: Examples of the layout of on-ground plots using (A) circular quadrats (note: all plots are represented within the remote sensed plot) and (B) transect-based approach (note: only the central plot is represented).

Table 5: Summary of on-ground techniques used to measure each of the composition Indicators

Quadrat area	Number of quadrats at central plot	Number of quadrats at each additional plot	Data collected
1 m^2	3	3 each	- Estimated projected foliage percent cover of native herbaceous plants (Indicator I) - Estimated projected foliage percent cover of non-native herbaceous plants (Indicator M) - Estimated projected percent cover of cryptogams (Indicator O) - Estimated projected percent cover of prostrate and small shrubs that are **no taller** than the herbaceous ground layer (Indicators G and H) *- Organic Litter percent cover (but* ***only*** *in areas where high canopy density does not permit adequate sampling of the ground layer using high-resolution remote sensing)* (Indicator N)
0.05 ha (500 m^2)*	1	1 each but only to record native and non-native shrub cover	- Species richness (all native vascular plants) (Indicators E, J, K, L) - Estimated projected foliage percent cover of native shrubs (Indicator G) - Estimated projected foliage percent cover of non-native shrubs (Indicator H) - Estimated projected foliage percent cover of immature trees (Indicator F) - Tree health and tree density in densely wooded areas (Indicators B, D)
0.1 ha (1,000 m^2)	1	0	- Tree health and tree density in sparsely wooded areas (Indicators B, D) *- Coarse woody debris (but* ***only*** *in areas where high canopy density does not permit adequate sampling of the ground layer using high-resolution remote sensing)* (Indicator P)
0.5 ha (5,000 m^2)	1	0	- Species composition (only for any additional tree species not previously recorded in the 0.05 ha quadrat) (Indicator E)

* In NSW, the Biodiversity Assessment Methodology uses a 20x20m or 0.04 ha quadrat

5.3.1. Procedure to photograph the on-ground plots:

- Landscape-format photographs of the plot/transect are required to help illustrate the changes occurring at an on-ground plot over time. There are three photos taken at the centre of the central plot-first at 0 degrees (i.e., facing north or along the transect), second at 180 degrees and a third photo of the ground cover.

5.3.2. Procedure to collect cover data for herbaceous species, cryptogams, prostrate/small shrubs and, where applicable, organic litter (1m^2 quadrat size) - Indicators G, H, I, M, O, (N):

- Photograph each 1m^2 plot.
- Record the estimated projected cover to the nearest 5% when cover of a category is >10%, and the nearest 1% when cover of a category is <10% (1% is the equivalent of 10cm x 10cm in a 1m^2 quadrat) for:
    - Cryptogams, that is Bryophytes and Lichens and only include Algal Crust if it can be readily detected;
    - Native Prostrate and Small Shrubs, that are **no taller** than the foliage of the tallest herbaceous species present in the ground layer;
    - Non-Native Prostrate and Small Shrubs;
    - Native Herbaceous (photosynthetic) ground cover plants, that is all grasses, graminoid species, ferns and forbs (but excluding grass trees, cycads, tree ferns, epiphytes, and lianas). The cover of individual species is not required;
    - Non-Native Herbaceous ground percent cover (plants, that is all grasses, graminoid species, ferns and forbs (but excluding grass trees, cycads, tree ferns, epiphytes, and lianas). The cover of individual species is not required); and
    - Organic Litter cover, but **only** where canopy density does not permit adequate sampling of the ground layer using high-resolution remote sensing. When litter is measured using on-ground Methods, it can be defined as dead organic material (either attached or detached from the parent plant), including leaves, bark and twigs estimated to be <10cm diameter.
- The cryptogam percent cover, native and non-native herbaceous and small shrub plant cover are used to split (if required) the remotely sensed measure of ground cover into these five categories.

5.3.3. Procedure to collect species richness data for all vascular plant species and tree health and density data (0.05 ha / 500m^2 quadrat) and, where applicable, expand the quadrat out to 0.5 ha / 5,000m^2 quadrat to record any additional tree species only – Indicators B, D, E, F, G. H, J. K, L:

- Count every vascular plant species within the 0.05 ha quadrat (including all shrubs, trees, graminoids, forbs, grass trees, cycads, tree ferns, epiphytes, and lianas) and at a minimum, record the five most dominant species by projected foliage cover (with sufficient species to identify the Sub-asset, including representative species from each strata present). Where required, the quadrat may be expanded to 0.5 ha to include any additional tree species (only) not previously detected in the 0.05 ha quadrat.
- Record the estimated projected cover to the nearest 5% when cover of a category is >10%, and the nearest 1% when cover of a category is ≤10% (1% is the equivalent of 5m^2 in a 0.05 ha quadrat) for:
    - Native Shrub cover (excluding shrubs **no taller** than the foliage of the tallest herbaceous species present in the ground layer). Overall cover is recorded, not groupings or individual species.

- Non-Native Shrub cover. (As above, same conditions apply).
- Immature Tree cover (i.e., the cover of immature trees that are shorter that the average height of the tallest shrub species).

- Record the number of Large Trees (as defined by any applicable State / Territory benchmark) or the number of trees with a diameter estimated ≥100mm at breast height. (Alternatively, use a suitable remote sensing approach to record native tree structure.)
- Record the health score of the canopy of any trees with a stem diameter estimated to be ≥100mm at breast height -or select the most appropriate (narrower) diameter based on the community being sampled (i.e., for mallee or short-stature trees). To keep track of all the trees within the quadrat it may be helpful to mark all standing trees with flagging tape and remove the tape from a tree once the health score has been recorded. If the number of trees in the quadrat is less than 10, then double the quadrat area (see next section).
    - Determine the crown health / condition stage by applying the following criteria and by comparing it with diagrams (see Appendix F). The crown of each tree is scored on a scale from 0 (completely dead trees) to 5 (healthy crowns with very few dead branches or leaves).
    - Category 5: The canopy is ‘full’ - the volume of the canopy matches the diameter of the trunk. There are no fallen major limbs and there is only natural attrition of the foliage and/or minor branches. Canopy loss of up to 10% is permitted. Epicormic growth is typically absent.
    - Category 4: Canopy loss of between 10-25 %, +/- epicormic growth.
    - Category 3: Canopy loss of between >25-50 %, +/- epicormic growth.
    - Category 2: Canopy loss of between >50-75 %, +/- epicormic growth.
    - Category 1: Canopy loss of over >75 %, +/- epicormic growth.
    - Category 0: Completely dead tree.
    - Note: for trees where the entire main trunk has died due to drought or fire, any epicormic shoots from the base of the tree are assessed against the estimated diameter of the new, emerging trunk so they are only recorded if/when the estimated diameter of the one new stem is ≥100mm at breast height. Therefore, if the resprouted foliage is healthy and stem diameter is ≥100mm, then the health score is Category 5. If the main stem is not dead, then any resprouting foliage on the plant is assessed against the expected canopy size for that trunk diameter. Therefore, if the plant was recently defoliated by fire but it is resprouting from epicormic shoots on the trunk or major limbs, then the score is likely to be Category 1.

5.3.4. Procedure (where applicable) to collect coarse woody debris data in areas of dense canopy cover or tree health data in open woodlands (0.1 ha / 1,000 m^2 quadrat) - Indicators B, D, (P):

- Record the coarse woody debris, but **only** in areas where high canopy density does not permit adequate sampling of the ground layer using high-resolution remote sensing.
    - Measure either the length (metres) or area (m^2) of any fallen timber substantially detached from the parent tree with an estimated diameter of ≥ 100mm.
- Record the health score of the canopy of any trees with an estimated diameter of ≥100mm at breast height (or select the most appropriate diameter based on the community being sampled). Follow the same procedure for assessing tree health as outlined in the previous section.

5.4. High-resolution remote sensing data collection

The application of emerging remote sensing techniques such as UAVs can rapidly and efficiently survey ecosystem attributes. Remotely sensed data can be collected using a broad range of tools (terrestrial laser scanners (TLS), copter and fixed wing UAVs, Aircraft, sensors e.g., RGB, multispectral, hyperspectral, LiDAR, etc.); collection configurations (height, speed, etc.); pre-processing pipelines; georeferencing procedures; and means of quantifying metric values from remotely sensed data (e.g., supervised classification)). Because this technology is evolving rapidly, this Method does not prescribe remote sensing tools or workflow details (although some details will need to be included in an Account, see below). Rather, remote sensing data shall be used under the Method to assess ecosystem attributes provided three criteria (which are discussed in more detail below) are met:

1. Aerial coverage is sufficient for a sampling plot size of 5 ha or greater, and data collection and pre-processing steps are documented,
2. The pre-processed data are fit for purpose, and
3. Statistically robust Methods are used to assess the accuracy of attributes, and accuracy meets pre-defined thresholds.

5.4.1. Criteria 1: Sufficient aerial coverage and documentation of data collection, pre-processing and analysis

No standardised guidance exists for designing remote sensing data collection for environmental monitoring (Tmušić et al., 2020). The spectrum of available technology and the rate of technological development make it impractical to prescribe specific sensors, platforms, mission planning software, georeferencing workflows, or data processing software/algorithms. Instead, it is proposed these parameters can be project specific, and must be detailed in the Account Information Statement. For the application of UAV, account managers may consider consulting recent review papers such as Tmušić et al. (2020) or Cruzan et al. (2016) to guide their survey design. To ensure replication is sufficient to assess condition, replication of remotely sensed plots needs to meet the requirements laid out in Table 1, and each remotely sensed plot needs to cover 5 ha or greater. For Sub-assets where all patch sizes are <5 ha (e.g., small wetlands), the remotely sensed plot will capture the whole of patch, or data can be merged from two or more patches to create a 5-ha sample but only if all patches are in close proximity and they are part of the same Assessment Unit.

Details of the protocols used to collect and analyse high-resolution remote sensing data are required by this Method. This includes hardware (make and model, cameras and sensors used), flight or collection parameters (e.g., flight parameters when using UAV), pre-processing and analysis approach. While the overall analytical approach must be described in the Information statement, any proprietary information can be kept confidential (however proprietary information may be requested as confidential supporting information during the Environmental Account Audit).

Case study: Documenting data collection and pre-processing steps

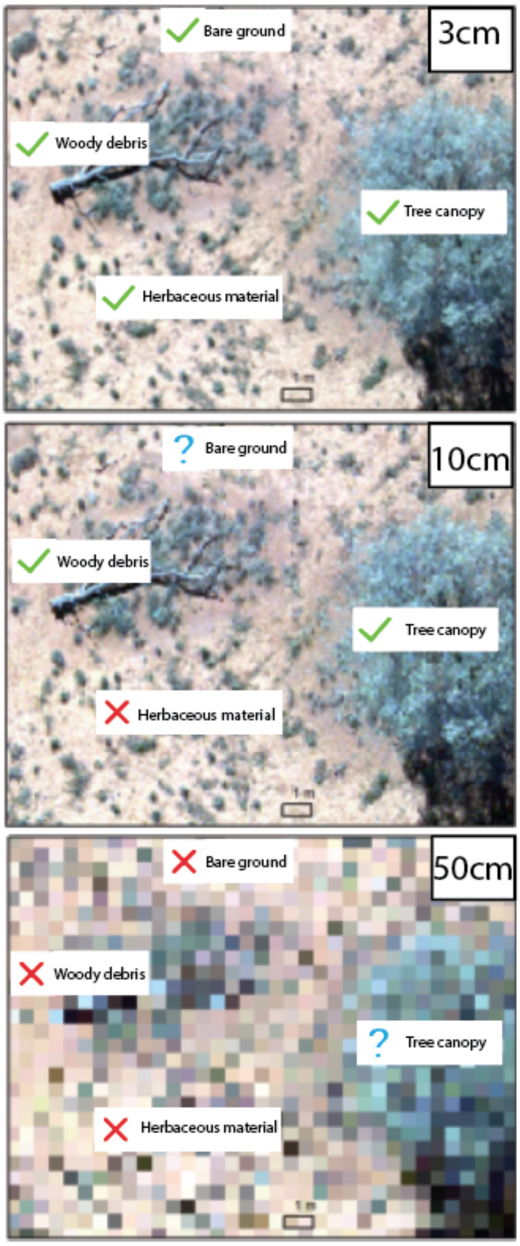
A DJI Mavic 3 Multispectral with an integrated 4 band multispectral camera was flown at 80 m above ground level, with 30 m line spacings at a speed of 5 m per second. These settings produced 90% forward and side overlap and a ground sample distance of 2 cm. The Agisoft© photoscan software was used to generate orthomosaics and a point cloud from the images. Object based image analysis and a random forest algorithm were applied to classify indicators within the imagery. A total of 6ha were surveyed per plot, and a total of 8 plots in assessment unit 2, 5 in assessment unit 3, 6 in assessment unit 4, and 3 in assessment unit 5.

5.4.2. Criteria 2: Data are fit-for-purpose.

The key criterion at this stage will be whether the collected and pre-processed data are fit-for-purpose, and data collection and processing shall aim to minimise data gaps, artefacts, and shadows. Raster data (e.g., imagery or canopy height data) shall also be of sufficient resolution or ground sampling distance (GSD); data shall be collected in such a way that the GSD is small relative to the target features, and mixed pixels (with more than one class) are minimised. To assess if data are fit for purpose, users need demonstrate that resolution and image quality are sufficient that target vegetation strata can be delineated within the plot area (e.g., between tree, shrubs, and bare ground). The hypothetical case study below demonstrates how GSD impacts whether data are fit-for-purpose, with objects becoming less visible with decreasing resolution. At assessment sites where canopy cover obscures below-canopy indicators, or situations when indicators cannot be visually separated from one-another, the high-resolution remote sensing data will not be considered fit-for-purpose. These indicators will be derived using on-ground Methods and could include the use of technologies such as TLS (outlined in Table 4).

Case study: Demonstrating that data are fit-for-purpose

Below is a hypothetical assessment as to whether data are fit-for-purpose. A snippet of a pre-processed Red-Green-Blue (RGB) UAV orthomosaic, resampled to five different Ground Sampling Distances (GSD) (3, 5 10, 25 and 50 cm) is shown. For each GSD, a qualitative assessment has been made as to whether coarse woody debris, bare ground, herbaceous material and tree canopy are clearly interpretable within the image (✓ = Yes,? = Possibly, and X = No).



5.4.3. Criteria 3: Accuracy meets pre-determined thresholds

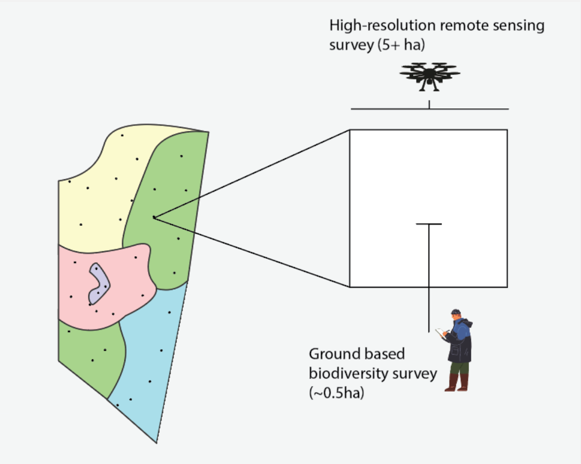
If Criterion 2 is met, it follows that a user-interpretation of a sample of objects or pixel labels in the dataset can be relied upon to check the reliability of any classifications used to derive vegetation condition metrics. The manual interpretation of high-resolution image data is a widely used and accepted means to verify map accuracy in the remote sensing discipline and literature. The benefits of this approach are the efficiency with which validation can be done, and the avoidance of uncertainty in spatial alignment between field-based validation data and remotely sensed data. These benefits outweigh the potential drawbacks, such as the occasional uncertainty in image-based label interpretation.

The proposed strategy for verification involves a point-based sample that is distributed probabilistically throughout the plot areas. For most situations, a simple random sample would be suitable (Stehman, 1999). If, however, one or more classes are rare, a stratified random sample might be more appropriate (Stehman, 1999). Since the metrics of interest are area-based, a point-based verification remains appropriate even if the mapping algorithm is object-based (i.e., involving image segmentation and the classification of segments, rather than individual pixels) (Radoux and Bogaert, 2017).

In broad terms, points are randomly generated within the classified image. Then, the class of each point is assigned by manual annotation and compared with the automatic classification. Finally, the proportion of correctly classified points is tallied for each attribute. A confusion matrix must be reported detailing the accuracy of each indicator, and the overall accuracy of the classification must be above 75% to be considered appropriate for a 95% Accuracy Account and 65% for a 90% Accuracy Account. For an 80% Accuracy Account, proponents are required to calculate and report Accuracy. Considerations for the assessment of ecosystem attributes using high-resolution remote sensing, and technical requirements for accuracy assessment can be found in Appendix E.

Output of Step 5

- A map and table with coordinates of central points for each remote sensing and on-ground assessment plots.
- A table containing all raw data for each indicator at each assessment site.
- All on-ground plot photographs and high-resolution remote sensing data.
- Both mapped and observed Sub-assets for each assessment site, and demonstrate the validation of the stratification.
- Evidence of accuracy assessment for high-resolution remote sensing data, including demonstration that imagery/data are fit-for-purpose.



Step 6. Validate Stratification

6.1 Validate Stratification

Vegetation labels from Step 5.1 may be used to validate the stratification. If strata are labelled, compare the field described label (from Step 5.1) to its corresponding stratification mapped label (from Step 3) for each point. When these labels match, the stratification is considered correct. Overall precision can be calculated as follows:

$$Precision = \frac{Number\ of\ points\ when\ field\ label\ matches\ stratification\ label}{Total\ number\ of\ points}$$

When strata are unlabelled (for example, if stratification relied on an unsupervised clustering or alternative mapping such as geology layers – see Step 2 and 3), a pair confusion matrix can be used to evaluate the extent to which field-labelled classes match the unlabelled strata. This process is detailed in Appendix C.

If precision results do not meet the accuracy requirement (See Method Snapshot, stratification accuracy), revise the stratification accordingly. The distribution of sample points within revised stratification will determine if there is a need for top-up sampling (see See Method Snapshot, Sample intensity for the required sampling effort).

6.2 Validate Reference Benchmark Stratification (if relevant)

When a neighbouring property or landscape is being used for reference site selection, validate dynamic reference benchmark stratification and apply Step 6.1 within the reference area.

Output of Step 6

Provide both mapped and observed Sub-assets for each assessment site, and demonstrate the validation of the stratification.

Step 7. Calculate Indicator Condition Scores

Indicator Condition Scores (ICS) generally represent the proportion (expressed as a percentage) to which the observed values compare to the Reference Benchmark value for each indicator. Each indicator within the Configuration and Composition Indicator Classes is converted to an index ranging from 0-100. There are formulas for calculating these indices that vary considerably between the indicators. In some cases, weightings and/or conditional clauses are applied to reflect certain ecological thresholds (e.g., tree density increases to an optimal value/range, above which the condition starts to deteriorate).

The Extent Indicator Class values are not used in the same way as other indicator classes. The extent of each assessment unit is used in Step 8 when aggregating the Econd® using area-weighted averages.

To calculate the Configuration Indicator Condition Score (the only Indicator within the Configuration Indicator Class), a GIS is used to calculate the proportion of remnant vegetation retained within a 1-km radius of each assessment site (taken from the center of the high-resolution remote sensing plot). If the percentage of native vegetation within a 1 km radius of the assessment site is 86% then the ICS is 86. Only areas of recently cleared land and areas of highly modified (non-native) vegetation are regarded as non-remnant vegetation. A paddock with remnant native trees and an understorey of introduced pasture will be regarded as remnant vegetation (though the composition indicator scores will be very low).

For the Composition Indicators listed in Table 2, a continuous scoring system (i.e., not an interval score system) is applied to the field data using the applicable transformation formula outlined in Table 6. The composition values measured across all assessment sites within each Assessment Unit shall be averaged, and these averaged values used to calculate the ICS. Where attributes are naturally missing in a Sub-asset (e.g., tree indicators in treeless vegetation types such as grasslands, wetlands) they do not contribute to the score for that assessment site.

Table 6: Formulae to calculate Indicator Condition Scores for Composition Indicators. See Appendix H for equivalent excel formulas.

<table>
<tr><th>Indicator</th><th>Data source</th><th>Indicator Condition Score (ICS)</th></tr>
<tr><td colspan="3">Height and Health</td></tr>
<tr><td>A) Native Tree Canopy height (m)</td><td>High-resolution remote sensing</td><td>An ICS will be calculated for the height of the tree canopy in accordance with below table (simplified from AfN-METHOD-NV-01 (Butler, 2020)):
<table>
<tr><th>Height (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><10%</td><td>0</td></tr>
<tr><td>10 – <20%</td><td>8</td></tr>
<tr><td>20 – <30%</td><td>25</td></tr>
<tr><td>30 – <40%</td><td>41</td></tr>
<tr><td>40 – <50%</td><td>58</td></tr>
<tr><td>50 – <60%</td><td>76</td></tr>
<tr><td>60 – <70%</td><td>93</td></tr>
<tr><td>≥70%</td><td>100</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Data source</th><th>Indicator Condition Score (ICS)</th></tr>
<tr><td>B) Native tree canopy health score (%)</td><td>Quadrat
OR
High-resolution remote sensing (potentially canopy porosity).</td><td>An ICS will be calculated for the canopy health of trees* in accordance with table below:
<table>
<tr><th>Health (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><90 %</td><td>$ICS=\frac{Score}{Reference} \times 100$</td></tr>
<tr><td>≥90%</td><td>100</td></tr>
</table>
*Any individual tree with an estimated DBH ≥100 mm.
If benchmark is 0, then ICS is ‘NA’</td></tr>
<tr><td colspan="3">Cover</td></tr>
<tr><td>C) Native Tree Canopy cover (%)</td><td>High-resolution remote sensing</td><td>An ICS will be calculated for the cover of the tree canopy in accordance with table below (modified from AfN-METHOD-NV-01 (Butler, 2020)):
<table>
<tr><th>Cover (as % of benchmark)</th><th>ICS</th></tr>
<tr><td>0 – <75 %</td><td>$ICS= 135 \times \frac{Score}{Reference}$</td></tr>
<tr><td>75 – 125%</td><td>100</td></tr>
<tr><td>>125 -250 %</td><td>$ICS= -40 \times \frac{Score}{Reference} +140$</td></tr>
<tr><td>>250%</td><td>40</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
<tr><td>G) Native Shrub cover (%)</td><td>High-resolution remote sensing (scaled by Quadrat method)</td><td>An ICS will be calculated for the cover of shrub layer in accordance with table below (modified from AfN-METHOD-NV-01 (Butler, 2020):
<table>
<tr><th>Cover (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><10 %</td><td>0</td></tr>
<tr><td>10 – <75 %</td><td>$ICS= 135 \times \frac{Score}{Reference}$</td></tr>
<tr><td>75 – 150%</td><td>100</td></tr>
<tr><td>>150 -250 %</td><td>$ICS= -40 \times \frac{Score}{Reference} +160$</td></tr>
<tr><td>>250%</td><td>60</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Data source</th><th>Indicator Condition Score (ICS)</th></tr>
<tr><td>H) Non-native shrub & tree cover (%)</td><td>High-resolution remote sensing (scaled by Quadrat method)</td><td>An ICS will be calculated for the cover of non-native tree and shrub species with table below:
<table>
<tr><th>Cover (benchmark = 0%)</th><th>ICS</th></tr>
<tr><td>≤40 %</td><td>ICS = 100 - (2.5 x Score)</td></tr>
<tr><td>>40%</td><td>0</td></tr>
</table></td></tr>
<tr><td>I) Native herbaceous (photosynthetic) cover (%)</td><td>High-resolution remote sensing (scaled by Quadrat method)</td><td>An ICS will be calculated for the cover of native herbaceous species with below table (modified from AfN-METHOD-NV-01 (Butler, 2020)):
<table>
<tr><th>Cover (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><80 %</td><td>$ICS = \frac{Score}{Reference} \times 115$</td></tr>
<tr><td>≥80%</td><td>100</td></tr>
</table></td></tr>
<tr><td>M) Non-native herbaceous (photo-synthetic) cover (%)</td><td>High-resolution remote sensing (scaled by Quadrat method)</td><td>Non-native herbaceous plant cover will be given an ICS in accordance with the below:
<table>
<tr><th>Cover (benchmark = 0%)</th><th>ICS</th></tr>
<tr><td>≤50 %</td><td>ICS = 100 - (2 x Score)</td></tr>
<tr><td>>50%</td><td>0</td></tr>
</table></td></tr>
<tr><td>N) Organic litter i.e., non-photosynthetic ground cover (brown or dead) (%)</td><td>High-resolution remote sensing (potentially scaled by quadrat method)</td><td>An ICS will be calculated for the cover of organic litter ground cover with below table (simplified from AfN-METHOD-NV-01 (Butler, 2020)):
<table>
<tr><th>Cover (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><10 %</td><td>0</td></tr>
<tr><td>10 – <75%</td><td>$ICS = 135 \times \frac{Score}{Reference}$</td></tr>
<tr><td>75– 150%</td><td>100</td></tr>
<tr><td>>150 -250 %</td><td>$ICS = -60 \times \frac{Score}{Reference} + 190$</td></tr>
<tr><td>>250%</td><td>40</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Data source</th><th>Indicator Condition Score (ICS)</th></tr>
<tr><td>O) Cryptogam cover (%)</td><td>Remote sensing (scaled by Quadrat method</td><td>An ICS will be calculated for the cover of cryptogams with below table (modified from AfN-METHOD-NV-01 (Butler, 2020)):
<table>
<tr><th>Cover (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><10 %</td><td>0</td></tr>
<tr><td>10 – <75%</td><td>$ICS= 135 \times \frac{Score}{Reference}$</td></tr>
<tr><td>75– 150%</td><td>100</td></tr>
<tr><td>>150 -250 %</td><td>$ICS= -40 \times \frac{Score}{Reference} +160$</td></tr>
<tr><td>>250%</td><td>60</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
<tr><td colspan="3">Counts</td></tr>
<tr><td>D) Native tree size structure (height variability OR mature tree stems/ha)</td><td>Remote sensing</td><td>An ICS will be calculated for the tree size structure in accordance with table below:
<table>
<tr><th>Native tree size structure (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><10 %</td><td>0</td></tr>
<tr><td>>10 – 75 %</td><td>$ICS= 135 \times \frac{Score}{Reference} -25$</td></tr>
<tr><td>>75 – 150%</td><td>100</td></tr>
<tr><td>>150 - 250 %</td><td>$ICS= -60 \times \frac{Score}{Reference} +190$</td></tr>
<tr><td>>250%</td><td>40</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
<tr><td>E) Native species count (richness) – tree canopy and shrub species (number)</td><td>Quadrat / State-based assessment method</td><td>An ICS will be calculated for the count of tree and shrub species richness in accordance with table below:
<table>
<tr><th>Count (as % of benchmark)</th><th>ICS</th></tr>
<tr><td>≤80 %</td><td>$ICS= \frac{Score}{Reference} \times 125$</td></tr>
<tr><td>>80%</td><td>100</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Data source</th><th>Indicator Condition Score (ICS)</th></tr>
<tr>
<td>J, K, L) Native species count (Richness) – herbaceous species (number)</td>
<td>Quadrat(s) / State-based assessment method</td>
<td>An ICS will be calculated for the count of herbaceous species in accordance with table below:
<table>
<tr><th>Count (as % of benchmark)</th><th>ICS</th></tr>
<tr><td>≤80 %</td><td>$ICS= \frac{Score}{Reference} \times 125$</td></tr>
<tr><td>>80%</td><td>100</td></tr>
</table>
</td>
</tr>
<tr>
<td>F) Recruitment native tree species (number)</td>
<td>Quadrat(s) / State-based assessment method</td>
<td>An ICS will be calculated for the recruitment of tree species in accordance with table below:
<table>
<tr><th>Recruitment (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><90 %</td><td>$ICS= \frac{Score}{Reference} \times 100$</td></tr>
<tr><td>≥90%</td><td>100</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’
</td>
</tr>
<tr>
<td>P) Coarse woody debris</td>
<td>Remote sensing (% cover) or Quadrat / State-based assessment method</td>
<td>An ICS will be calculated as percent cover (using remote sensing) OR for the length of fallen logs (>100mm diameter) if sampled in the field in accordance with table below:
<table>
<tr><th>Distance (as % of benchmark)</th><th>ICS</th></tr>
<tr><td><75%</td><td>$ICS= 135 \times \frac{Score}{Reference}$</td></tr>
<tr><td>>75 - 125</td><td>100</td></tr>
<tr><td>>125 - 250</td><td>$ICS= -40 \times \frac{Score}{Reference} +150$</td></tr>
<tr><td>>250</td><td>50</td></tr>
</table>
If benchmark is 0, then ICS is ‘NA’
</td>
</tr>
</table>

Output of Step 7

- Table with Reference Benchmark values for each indicator for each Sub-asset, with justification for any local, published, modelled and/or expert elicited benchmarks.
- Table containing all calculated Indicator Condition Scores (ICS).

Step 8. Calculate the Econd®

The Econd® is an index between 0 and 100, where 100 describes the 'ideal' or 'undisturbed' reference condition of an environmental asset, and 0 indicates the asset is completely degraded. The Econd® is calculated as the product of the Quantity (extent) times the Quality (composition and configuration). As the condition and type of native vegetation typically varies over an area, the Account must adequately express these differences. In the simplest example, if an area contained 50% intact native grassland, and 50% sown pastures (assumed to have an Econd® of 0), then the highest Econd® the Account can get is 50.

This Method prescribes instructions for calculating Econd® indices for each Assessment unit, and then aggregating these into an Econd® for each Vegetation Sub-asset and then aggregating these into the overall Econd® for the native vegetation Asset Account.

The following steps must be taken to calculate the Econd®:

1. First, an Econd® index must be calculated for each **Assessment unit** (AU) by calculating the weighted average of the configuration ICS (weighted 25%) and the average of all composition ICS (weighted 75%).
2. Second, the **Sub-asset** Econd® is calculated as the area-weighted average of the **Assessment unit** Econd®.
    a. *Note: Area weightings for Assessment units shall be calculated as a proportion of the Assessment unit area (ha) to the total accounting area (ha). The sum of all Assessment units shall equal the total accounting area. As an example, if a 1,000 ha reserve comprised only two Assessment units, one covering 800 ha and the other covering 200 ha, then the reserve* Econd® *would be: (*Econd®*AU1 x 0.8) + (*Econd® *AU2 x 0.2).*
    b. *Note: the total accounting area shall remain consistent over time.*
3. Lastly, the Econd® for the Vegetation Asset is calculated for the Account as a whole (i.e. property, project or reserve) as an area-weighted average of the **Sub-asset** Econd® indices.

A worked example of how to organise your Environmental Account, and calculate the Assessment unit Econd®, Vegetation Sub-asset Econd®, and overall Econd® is shown on the following page.

Output of Step 8

Table containing Econd® scores for Assessment Units, Sub-assets and Accounting Area.

Step 1 and 2:	Step 3:	Step 4:			Step 5:	Step 7:		Step 8:		
Sub-asset	**Assessment unit**	**Indicator**		**Reference Benchmark Value**	**Average Measure**	**Indicator Condition Score (ICS)**		**Assessment Unit Econd®**	**Sub-asset Econd®**	**Property Econd®**
Grassy Woodlands	Previously grazed woodland	**Configuration**- site context (%)		100	41.0	41.0		55.4 (The weighted average of composition (75%) and configuration (25%) ICS) = (60.2*0.75) + (41.0*0.25)	70.7 (Area-weighted average of Assessment Unit Econd™) *= (55.4*0.53) + (88.0*0.47)*	71.1 (Area weighted average of each Conservation Target Econd®) *=(70.7*0.92)+ (76.1*0.08)*
		Composition	Tree canopy height (m)	20	18	100	60.2 (Average of all composition Indicators)			
			Native tree canopy health score (%)	5	3.45	69				
			Tree canopy cover (%)	15	11	100				
			Native shrub cover (%)	22	5	45				
			Non-native shrub / tree cover (%)	0	4	90				
			Native herbaceous cover (%)	75	47	63				
			Non-native herbaceous cover (%)	0	41	18				
			Non-photosynthetic ground cover (i.e litter) (%)	20	18	100				
			Cryptogam cover (%)	5	2	75				
			Native tree size structure (stems/ha)	10	4	75				
			Native tree species recruitment	12	0	0				
			Native species count - shrubs + trees	12	4	42				
			Native species count - forbs	24	12	63				
			Native species count - graminoids	10	5	63				
			Coarse woody debris (%)	300	90	60				
	Remnant woodland	**Configuration**- site context (%)		100	90.2	90.2		88.0 (The weighted average of composition (75%) and configuration (25%) ICS) = (87.3*0.75) + (90.2*0.25)		
		Composition	Tree canopy height (m)	20	22	100	87.3 (Average of all composition Indicators)			
			Native tree canopy health score (%)	5	4.6	100				
			Tree canopy cover (%)	15	14	100				
			Native shrub cover (%)	22	16	100				
			Non-native shrub / tree cover (%)	0	2	95				
			Native herbaceous cover (%)	75	78	100				
			Non-native herbaceous cover (%)	0	15	70				
			Non-photosynthetic ground cover (i.e litter) (%)	20	18	100				
			Cryptogam cover (%)	5	2	75				
			Native tree size structure (stems/ha)	10	11	100				
			Native tree species recruitment	12	0	0				
			Native species count - shrubs + trees	12	8	83				
			Native species count - forbs	24	18	94				
			Native species count - graminoids	10	9	92				
			Coarse woody debris (%)	300	240	100				
Grasslands	Previously grazed grassland	**Configuration**- site context (%)		100	82.6	**82.6**		76.1 (The weighted average of composition (75%) and configuration (25%) ICS) = (73.9*0.75) + (82.6*0.25)	76.1 (Area-weighted average of Assessment Unit Econd™) = (76.1*1.00)	
		Composition	Tree canopy height (m)	NA	NA	NA	73.9 (Average of all composition Indicators – excluding those naturally absent)			
			Native tree canopy health score (%)	NA	NA	NA				
			Tree canopy cover (%)	NA	NA	NA				
			Native shrub cover (%)	10	6	100				
			Non-native shrub / tree cover (%)	0	NA	NA				
			Native herbaceous cover (%)	88	67	76				
			Non-native herbaceous cover (%)	0	26	48				
			Non-photosynthetic ground cover (i.e litter) (%)	10	3	50				
			Cryptogam cover (%)	5	3	100				
			Native tree size structure (stems/ha)	NA	NA	NA				
			Native tree species recruitment	NA	NA	NA				
			Native species count - shrubs + trees	5	2	50				
			Native species count - forbs	40	36	96				
			Native species count - graminoids	15	10	71				
			Coarse woody debris (%)	NA	NA	NA				

AREA WEIGHTINGS			
		Area	
Sub-asset	**Assessment unit**	**Total Area (ha)**	**Area Weighting**
Grassy Woodlands		1435	**92%**
	Previously grazed woodland	*760*	***53%***
	Remnant woodland	*675*	***47%***
Grasslands		125	**8%**
	Previously grazed grassland	*125*	***100%***
TOTAL		**1560**	

INDICATOR WEIGHTING FOR ECOND®	
Configuration	25%
Composition	75%
Total	100%

3. Compile Environmental Account and submit for certification

Steps 2 to 8 should be repeated at regular intervals (at least once every five years and in accordance with the chosen Reporting Period), as specified under the **Accounting for Nature® Standard**, to establish a trend over time for the Vegetation asset.

For an Environmental Account to be certified, it must be audited in accordance with the **Accounting for Nature® Standard** and **Accounting for Nature® Audit Rules** and adhere to the **Accounting for Nature® Environmental Account Rules**. Once an Environmental Account is Certified, it is listed in the Environmental Account Registry and the Proponent gains access to the **Accounting for Nature® Trustmark** and must adhere to the **Accounting for Nature® Claims Rules**.

For information on the process of having an Environmental Account Certified, refer to **Accounting for Nature® Environmental Account Rules**.

4. References

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Appendix A. Checklist of requirements for Environmental Asset Account

- ☐ Provide a description of the accounting area, including its location and size.
- ☐ Provide a table describing the purpose and scope of the account including a statement of materiality.
- ☐ Provide a vegetation map or GIS layer of the accounting area showing Sub-assets, including any TECs.
- ☐ Provide a map of the accounting area stratified into Assessment Units, including information about management activities/history or TEC information used to create the Assessment Units (if applicable).
- ☐ Decide on the intended reference benchmark approach.
- ☐ Generate a Data Collection Plan.
- ☐ Register the account with Accounting for Nature.
- ☐ List the indicators to be measured for each Sub-asset.
- ☐ Provide a map and table with coordinates of central points for each remote sensing and on-ground assessment site.
- ☐ Provide a table containing all raw data for each indicator at each assessment site.
- ☐ Provide access to all on-ground plot photographs and high-resolution remote sensing data.
- ☐ Provide evidence of accuracy assessment for high-resolution remote sensing data, including demonstration that imagery/data are fit-for-purpose.
- ☐ Provide both mapped and observed Sub-assets for each assessment site, and demonstrate the validation of the stratification.
- ☐ Provide a table with Reference Benchmark values for each indicator for each Sub-asset, with justification for any local, published, modelled and/or expert elicited benchmarks.
- ☐ Provide tables containing all calculated Indicator Condition Scores (ICS) and Econd® scores for Assessment Units and Accounting Area.

Appendix B. Glossary

Term	Definition
Assessment unit	Assessment units are homogenous units within the accounting area which determine where samples are to be taken. They do not have to be continuous, but rather, can be comprised of multiple small parts (so long as all parts of a single assessment unit have the same vegetation type and land use/management/condition).
Composition	The composition of native vegetation relates to its structure, function and the assemblage of species.
Configuration	The configuration of native vegetation relates to the configuration of that area of native vegetation within the landscape, with regard to connectivity, context and patch size.
Econd®	An index between 0 and 100 that describes the condition of an environmental asset where 0 means the asset is completely degraded, and 100 means the asset is in pristine condition.
Environmental Account	An Environmental Account is a single registered environmental accounting project that reports on the Condition of one or more Environmental Assets. Environmental Accounts are comprised of individual Environmental Asset Accounts. Under the Framework an Environmental Account includes all Environmental Account data, and the Information Statement.
Environmental Asset Account (“Asset Account”)	Environmental Accounts can be comprised of one or multiple Environmental Asset Accounts. An Asset Account individually reflects the condition of one Environmental Asset as specified by a single Accredited Method.
Extent	The extent refers to the area of vegetation within the Accounting Area.
High-resolution remote sensing	Includes high, very high, and ultra-high spatial resolution remote sensing, with pixel sizes of 5m or less. However, to delineate individual indicators, resolutions of between 1m and 1cm would generally be necessary. Platforms including un-crewed aerial vehicles (UAV), aircraft, terrestrial laser scanners, and satellites, may be appropriate for the capture of high-resolution remote sensing data.
Indicator Condition Score	In general terms, the Indicator Condition Score (ICS) is a proportion of the observed value compared to the Reference Benchmark value. However, the formulas for calculating this can vary considerably between indicators—some incorporate weightings and conditional clauses to reflect the ecological thresholds associated with some vegetation attributes.
Native plant	A native plant is considered to be any plant that naturally occurs within the vegetation type pre-1750.
Reference Benchmark	The Reference Benchmark is the condition of the Vegetation Sub-asset in an ‘undegraded’ state. For example, a vegetation community that has not experienced any negative impacts as a result of disturbance, edge effects, invasive species, or altered management regimes (e.g. fire) would be considered to exist in an ‘undegraded’ or ‘ideal’ state.
Remnant	Areas are deemed ‘remnant’ if the relevant State-based vegetation map (or on-ground assessment) categories a polygon as a native vegetation mapping unit (i.e. not cleared land, agricultural land, infrastructure etc).
Sub-assets	Sub-assets describe the vegetation types or communities that comprise the ‘native vegetation environmental asset’ within an account. These could include aggregations of similar existing mapping units.
UAV	Un-crewed aerial vehicle, otherwise referred to as drones

Appendix C. Assessing the precision of un-labelled stratification

In statistical terms, a stratification without labels is akin to an unsupervised classification or clustering of input data (see Step 3) and can be validated accordingly. Following standard practices for assessing unsupervised clustering, the recommended workflow involves first producing a 'pair confusion matrix' ***C*** by evaluating whether all possible pairs of validation points are clustered/grouped (or not) in the draft stratification (proposed in Step 3) and also clustered (or not) according to the vegetation community labels assigned by a qualified expert (as in Step 3). For simplicity, we define this second set of clusters as the 'reference assignment'. ***C*** is then defined as follows:

$$C = \begin{bmatrix} TN & FP \\ FN & TP \end{bmatrix}$$

Where ***TN*** (True Negative) is the number of pairs of stratification validation points that belong to different clusters in both the draft stratification and reference assignment, ***FN*** (False Negative) is the number of pairs that belong to different clusters in the draft stratification but the same cluster in the reference assignment, ***FP*** (False Positive) is the number of pairs that belong to the same cluster in the draft stratification but different clusters in the reference assignment, and ***TP*** (True Positive) is the number of paired stratification validation points that are in the same cluster in both the draft stratification and the reference assignment.

The pair confusion matrix is a useful diagnostic to assess under- or over-segmentation of the draft stratification (high FP indicates that the draft stratification is grouping different reference classes together, high FN indicates that the draft stratification is separating sample points from the same reference class). For this Method, a degree of over-segmentation (FN) is to be expected because vegetation types may reasonably be sub-divided into multiple Assessment Units according to vegetation condition, management, etc. At the same time, too much over-segmentation will prohibitively increase sampling costs. As a measure of balance, the suggested validation statistic is the pairwise precision, which rewards TPs and penalises FPs, but only penalises FNs indirectly insomuch as over-segmentation may simultaneously increase FNs and decrease TPs. Pairwise precision is computed as follows:

$$Precision = \frac{TP}{TP + FP}$$

Precision ranges from zero, indicating either that the stratification is random (TP = 0) or that the stratification is oversimplified (TP = 0, FP = high), to one, indicating that samples from the same Assessment Unit are always the same vegetation type (TP = high, FP = 0).

If Assessment Units in the validated stratification are not yet attributed with vegetation types, this needs to be done by the conclusion of Step 3, or prior to the calculation of any indicator scores. Having completed the validation, the field data shall be used to assign appropriate vegetation classes. A simple approach would be to assign the vegetation type belonging to the majority of sample points within each stratum.

Appendix D. Sources of State-based mapping and reference benchmarks (based on each States' Condition Assessment Framework)

Table D1. Summary of vegetation mapping in each State and Territory

State	Vegetation Mapping	Link	Data Name and Source
ACT	Vegetation Communities	https://actmapi-actgov.opendata.arcgis.com/datasets/act-vegetation-map-2018	ACT Vegetation Map 2018 Data provided by the ACT Government, 2018.
NSW	NSW Plant Community Types	https://datasets.seed.nsw.gov.au/dataset/nsw-bionet-vegetation-map-catalogue-collection36515	NSW Bionet Vegetation Map Data Collection Data provided by State Government of NSW and Department of Planning, Industry and Environment, 2016.
NT	Vegetation Associations (Uses NVIS framework)	https://nrmaps.nt.gov.au/nrmaps.html (online map) https://denr.nt.gov.au/land-resource-management/info-systems/natural-resource-maps/spatial-data-requests (geospatial data catalogue)	No state-wide vegetation mapping download product available (as of November 2020), although various vegetation resource surveys are available, otherwise NVIS v 5.1 data (or later) shall be used.
QLD	Regional Ecosystems	http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={22E1BC4E-BDFA-470A-AED8-04F38B4FCFC3}	Biodiversity Status of Pre-clearing Regional Ecosystems – Queensland (v11) Data provided by State Government of Queensland and Department of Environment and Science 2018.
SA	Floristic Groups (uses NVIS framework)	https://data.environment.sa.gov.au/NatureMaps (online map)	No vegetation mapping download product available (as of November 2020). Online mapping available (see below), otherwise NVIS v5.1 data (or later) shall be used.
TAS	Vegetation Communities	www.dpipwe.tas.gov.au/tasveg	TASVEG- the Digital Vegetation Map of Tasmania (v4.0) Data able to be provided by the Tasmanian Government by contacting the Geodata Client Services Section of the Information and Land Services Division, Department of Primary Industries, Parks, Water and Environment.
VIC	Ecological Vegetation Classes	https://discover.data.vic.gov.au/dataset/native-vegetation-modelled-1750-ecological-vegetation-classes (downloadable data) https://www.environment.vic.gov.au/biodiversity/naturekit (online map)	Native Vegetation – Modelled 1750 and Ecological Vegetation Classes Data provided by the Victorian Government and Department of Environment, Land, Water and Planning, 2020
WA	Vegetation Associations	https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006	Pre-European Vegetation
Australia Wide	Major Vegetation Groups and Sub-groups	https://www.environment.gov.au/land/native-vegetation/national-vegetation-information-system/data-products#mvg51	National Vegetation Information System (v5.1) Data provided by Commonwealth of Australia, 2018.

Table D2. Summary of published composition benchmark documentation for each State and Territory

State	Composition Benchmarks	Link
ACT	Vegetation Benchmarks Database	https://www.environment.act.gov.au/__data/assets/excel_doc/0004/719122/Vegetation-Benchmarks-Database.xls
NSW	BioNet Vegetation Condition Benchmarks	https://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/vegetation-condition-benchmarks
NT	Not available	-
QLD	BioCondition Benchmarks	https://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks%23benchmarks
SA	Native Vegetation Council (NVC) Bushland Assessment Manual	https://www.environment.sa.gov.au/topics/native-vegetation/clearing/vegetation-assessments
TAS	TasVeg Vegetation Condition Assessment	https://dpipwe.tas.gov.au/conservation/development-planning-conservation-assessment/planning-tools/monitoring-and-mapping-tasmanias-vegetation-(tasveg)/vegetation-monitoring-in-tasmania
VIC	Bioregions and EVC Benchmarks	https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks
WA	Not available	-
Australia Wide	Not available	NB. NVIS descriptions could contain some broad benchmark information.

Appendix E. Technical requirements and supporting information for accuracy assessment of remotely sensed classifications.

Table E1. Definition of terms used in formulas for sample determination and accuracy assessment.

Term	Definition
n	Sample size
n_{ij}	Number of sample points with reference class *i* and mapped class *j*
$n_{i\cdot}$	Total number of sample points with reference class *i*
$n_{\cdot j}$	Total number of sample points with mapped class *j*
n_{jj}	Number of sample points with mapped class *j* in agreement with reference class (found on the diagonal of the confusion matrix), can also be written n_{ii}
k	Number of classes
$\hat{U}$	Estimated user's accuracy
$\hat{P}$	Estimated producer's accuracy
$\hat{O}$	Estimated overall accuracy
d	Desired half-width of the 95% confidence interval for $\hat{O}$

The following formula, adapted from Cochran (1977) and Oloffson et al. (2014) can be used to determine a sample size for simple random sampling:

$$n = \frac{3.84 * O(1 - O)}{d^2}$$

Thus, for an expected overall accuracy of 0.8 (0.05 greater than the proposed threshold for acceptance of 0.75), and a desired 95% confidence interval half-width of 0.03 (or 3%), *n* is estimated at 683 points.

The randomly generated points need then to be overlaid onto the raw imagery, interpreted, and allocated a reference class, as well as extracting the mapped class for each point. This enables the construction of a confusion matrix:

$$\begin{bmatrix} n_{ij} & \cdots & n_{kj} \\ \vdots & \ddots & \vdots \\ n_{ik} & \cdots & n_{kk} \end{bmatrix} \quad \begin{bmatrix} \boldsymbol{n_{\cdot j}} \\ \vdots \\ \boldsymbol{n_{\cdot k}} \end{bmatrix}$$

$$[\boldsymbol{n_{i\cdot}} \quad \cdots \quad \boldsymbol{n_{k\cdot}}]$$

Where the vectors represent row-wise (j) and column-wise (i) summations of the matrix elements for each of the k classes.

The overall accuracy is estimated with:

$$\hat{O} = \frac{\sum_{j=1}^{q} n_{jj}}{n}$$

And the class-specific accuracies with:

$$\hat{U} = n_{jj}/n_{\cdot j}$$

$$\hat{P} = n_{ii}/n_{\cdot i}$$

Note that if a stratified random sample is chosen instead of a simple random sample, and if the sample sizes within each mapped class are not proportional to their respective abundances in the map (i.e. the same number of samples are generated for each class despite the classes having different mapped abundances), then the overall accuracy will be biased and not a true reflection of the 'general' map accuracy. It is recommended in this case that the elements in the confusion matrix are normalised by the area that each class occupies in the map. Detailed instructions can be found in Oloffson et al. (2014).

Considerations for data processing and metric estimation

Cover classification

Since available or preferred high-resolution remote sensing technology, and therefore the kind of output data (e.g., point clouds, imagery, etc.) can vary with survey design, it is sensible to allow for a variety of approaches to extracting the necessary information. Most metrics outlined in Table 4, however, require the estimation of percent cover, for which a wall-to-wall image classification is suitable. There are many ways to produce wall-to-wall image classifications. Machine learning approaches are common but may not always be the best option. There are also numerous possible input variables. Canopy height information provided by three-dimensional outputs of Structure-from-Motion (SfM) processing or LiDAR acquisition are commonly used to derive canopy area for trees and shrubs, and sometimes even grasses. When mapping for metrics such as herbaceous material (photosynthetic or not), bare ground, and woody debris, it is anticipated that colour imagery (or spectral bands) will be important predictors. Useful information contained in this data are the radiometric properties (or colour) of materials, and the texture (or local colour variability) and shape of objects.

Aggregation

Once target classes have been adequately mapped, GIS software can then be used to summarise their areal coverage as a percentage of the total plot area, which can in-turn be used to calculate indicator scores.

Shadows

Shadows cast by vegetation will be present in most UAV-derived imagery, obscuring part of the understory vegetation and/or soil. Accordingly, genuine shadows (where the true surface properties cannot be determined by manual interpretation) shall form a part of any classification based on optical data. Having classified areas of shadow, one approach to handling the shaded fraction at the aggregation stage, is to distribute it proportionally among the classes that are most likely to be within the shadows (e.g. bare ground, litter, grasses, woody debris, etc.). This strategy assumes that the composition of the unshaded surface is representative of the shaded surface.

Appendix F. Example of a Translated Benchmark using QLD Biocondition benchmarks

Table F1. Possible application of a Translated Benchmark, where published benchmarks are modified such that they are comparable to metrics collected under AFN-METHOD-NV-10. Where translated benchmark is "NA", either Local Benchmark, another source of published benchmark, or Modelled Benchmark values will need to be sourced.

AFN-METHOD-NV-10 indicator	**Suggested metric**	**Approach to translate published benchmark (QLD BioCondition) to indicators comparable with AFN-METHOD-NV-10**
a) Native tree canopy height	Mean or median height (m) of canopy trees	Direct comparison with the "tree_canopy_height" indicator
b) Native tree canopy health score	Health score rating from 1 to 5	NA, no benchmarks available
c) Native tree canopy cover	% of tree canopy cover	Merge the "emergent_canopy_cover", the "tree_canopy_cover", and "tree_subcanopy_cover" indicators
d) Native tree size structure	Size frequency distribution of trees classified within imagery	Total number of trees above the "tree_canopy_height" indicator
e) Native species count (richness for tree canopy and shrub layer species)	Number of tree and shrub species	Combine the "tree_sp_richness" and "shrub_sp_richness" benchmark values
f) Native tree species recruitment	Ratio of canopy species recruitment in the shrub layer	NA, benchmark not comparable
g) Native shrub cover	Shrub cover (%) x proportion of native shrubs	Directly comparable to "shrub_canopy_cover"
h) Non-native shrub and tree cover	As per Indicator (G) but for non-native shrubs + High- resolution remote sensing (non-native tree cover)	Directly comparable to "nn_plant_cover" (zero)
i) Native herbaceous (photosynthetic) cover	% photosynthetic ground cover	NA, benchmark only includes perennial herbaceous cover
j) Native species count for herbaceous species - graminoids	Number of species with non-grass graminoids excluded	Directly comparable to "grass_sp_richness"
k) Native species count for herbaceous species - forbs	Number of species, including non-grass graminoids	Directly comparable to "forb_other_sp_richness"
l) Native species count for herbaceous species - other species	NA	NA (included in "forb_other_sp_richness")
m) Non-native herbaceous cover	% cover	Directly comparable to "nn_plant_cover" (zero)

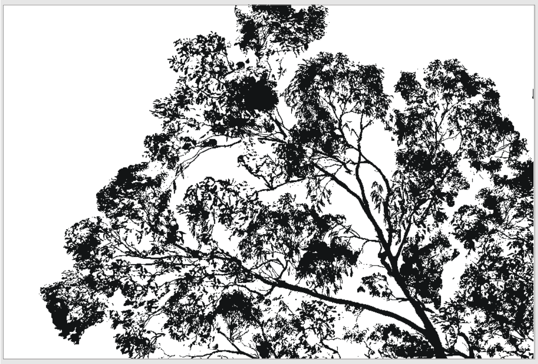
AFN-METHOD-NV-10 indicator	Suggested metric	Approach to translate published benchmark (QLD BioCondition) to indicators comparable with AFN-METHOD-NV-10
n) Organic litter i.e., non-photosynthetic ground cover (brown or dead)	% cover	Directly comparable to “litter_grd_cov”
o) Cryptogam cover (may exclude algae crust if no reference condition is available)	% cover	NA, no benchmarks available
p) Coarse woody debris	% cover of CWD	Using remotely sensed data, derive a CWD length to cover empirical equation. Then, use this equation to derive benchmark cover based on “woody_debris_length_ha” benchmark indicator.

Appendix G. Tree Health Proportion of expected healthy cover present

(Diagram taken from Department of Sustainability and Environment (Victoria) Vegetation Quality Field Assessment Sheet, Appendix 4)

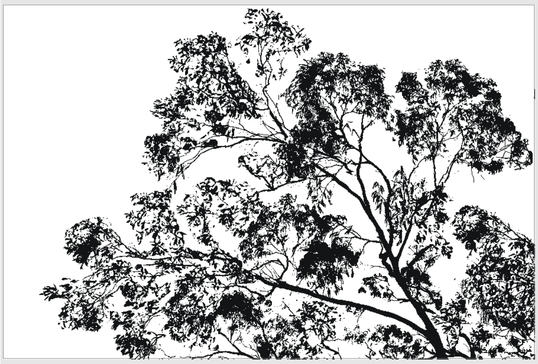
Proportion of healthy canopy cover present : 100%

Proportion of healthy canopy cover present : 45%



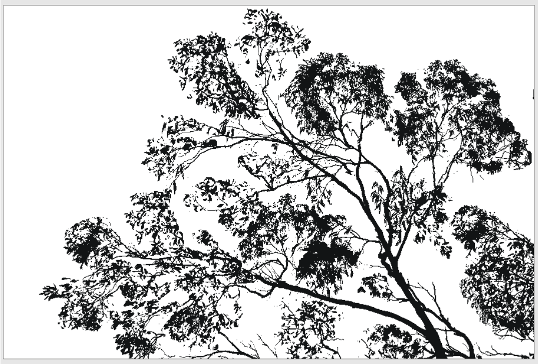
Proportion of healthy canopy cover present : 75%

Proportion of healthy canopy cover present : 30%



Proportion of healthy canopy cover present : 65%

Proportion of healthy canopy cover present : 20%



Proportion of healthy canopy cover present : 55%

Proportion of healthy canopy cover present : 10%

Appendix H. Excel Formulas for Indicator Condition Scores

In the below formulas:

OBS = Observed value

REF = Reference Benchmark Value

Indicator ID	Indicator	Excel formula to calculate indicator condition score
A)	**Native tree canopy height**	=IF(REF=0,"NA",IF((OBS/REF)<0.1,0,IF((OBS/REF)<0.19,8,IF((OBS/REF)<0.29,25,IF((OBS/REF)<0.39,41,IF((OBS/REF)<0.49,58,IF((OBS/REF)<0.59,76,IF((OBS/REF)<=0.69,93,100))))))))
B)	**Native tree canopy health score**	=IF((OBS/REF)<0.9,(OBS/REF)*100,100)
C)	**Native tree Canopy cover**	=IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF)<=1.25,100,IF((OBS/REF)<=2.5,- 40*(OBS/REF)+140,40)))
F)	**Native tree species recruitment**	=IF((OBS/REF)<0.9,(OBS/REF)*100,100)
G)	**Native shrub cover**	=IF((OBS/REF)<=0.1,0,IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF)<=1.5,100,IF((OBS/REF)<=2.5,-40*(OBS/REF)+160,60))))
H)	**Non-native shrub and tree cover**	=IF((OBS)<=40,100-(OBS)*2.5,0)
I)	**Native herbaceous (photosynthetic) cover**	=IF((OBS/REF)<0.8,(OBS/REF)*115,100)
M)	**Non-native herbaceous (photosynthetic) cover**	IF((OBS)<=50,100-(OBS)*2,0)
N)	**Organic litter i.e., non-photosynthetic ground cover**	=IF((OBS/REF)<=0.1,0,IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF) <=1.5,100,IF((OBS/REF)<=2.5,-60*(OBS/REF)+190,40))))
O)	**Cryptogam cover**	=IF((OBS/REF)<=0.1,0,IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF) <=1.5,100,IF((OBS/REF)<=2.5,-40*(OBS/REF)+1260,60))))

D)	**Native tree size structure**	=IF((OBS/REF)<=0.1,0,IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF)<=1.5,100,IF((OBS/REF)<=2.5,-60*(OBS/REF)+190,40))))
E)	**Native species count (richness) for tree canopy and shrub layer species**	=IF((OBS/REF)<=0.8,(OBS/REF)*125,100)
J, K, L)	**Native species count – herbaceous (graminoids, forbs and other)**	=IF((OBS/REF)<=0.8,(OBS/REF)*125,100)
P)	**Coarse woody debris**	=IF((OBS/REF)<=0.74,135*(OBS/REF),IF((OBS/REF)<=1.25,100,IF((OBS/REF)<=2.5,-40*(OBS/REF)+150,50)))

Appendix I. Justification of Accuracy Level

The criteria for determining what Accuracy Level/s (previously termed 'Confidence Level') a Method can achieve are outlined in *Accounting for Nature® Method Rules* (v.1.0, December 2023).

Materiality

The purpose of undertaking an Environmental Account using this Method is to provide information relevant to land management decisions that impact vegetation condition. Consideration should be given to the scope of the assessment to ensure effort and expense are not wasted collecting data that is not likely to be influenced by land management activities. Accounts are encouraged to follow the Accounting for Nature® Materiality Guidelines (https://www.accountingfornature.org/key-documents) when selecting which Environmental Assets and Locations to include in an Environmental Account.

In assessing changes in condition of vegetation related to land management across large tracts of land (>5000 ha), the materiality concerns can be addressed by accurate stratification and sampling accordingly. This may not result in very fine-scale vegetation class being sampled, but sufficient sampling of the stratified areas should provide confidence in the detection of change within these strata.

Accuracy

Traditional measures of vegetation condition have been designed to be measured by people on the ground. While measurement on-ground has benefits, as it enables species identification, it is less suited to sampling large areas or precisely measuring habitat structure and changes through time. For example, an on-ground sampling program can sample species diversity at individual sites with the best possible accuracy, but over a limited spatial area. On-ground sampling is not suited to measuring the three-dimensional structure of vegetation with high accuracy and cannot do so in a cost-effective way over large areas.

Remote sensing data such as RGB (Red-Green-Blue) or multispectral imagery and LiDAR (Light Detection And Ranging) point clouds collected with close-range, high-resolution remote sensing platforms such as unmanned aerial vehicles (UAVs) are more adept than human ground measures to assess the structure of vegetation over large spatial areas with high volumes of precise and accurate measurements, the precision of which is part of the specification of the hardware (Puliti, Breidenbach, & Astrup; 2020). Remote sensing presently has limited ability to identify the presence or absence of certain individual species. For example, remote sensing may be able to identify broad vegetation morphology over large spatial areas with high precision but is presently unable to directly quantify species richness at any spatial scale.

In summary, there are strengths and weaknesses to both remote sensing and ground-based field measurement of vegetation condition. The strengths are largely complementary. This Method seeks to leverage the strengths of available techniques to increase measurement certainty of the elements of vegetation condition with greater scale of sampling:

- Extent – remote sensing satellite imagery
- Configuration – remote sensing satellite imagery
- Structural Composition – high-resolution remote sensing structure (e.g., drone-based LiDAR or photogrammetry)
- Vegetation Composition – species richness – ecological ground measures

This combination will deliver greater statistical certainty of change in vegetation condition at lower costs as it removes the requirement for ecologists to be measuring individual elements (tree diameter, number, height, canopy cover and coarse woody debris). Rather, the on-ground ecologists can focus on species richness.

The Method draws on existing Accounting for Nature® Accredited Methods: The Land Restoration Fund Vegetation Condition Monitoring Method (NV-01), which mostly leverages remote sensing for stratification purposes, and the Bush Heritage Australia – Native Vegetation Assessment Method (NV-07), that mostly leverages on-ground sampling of vegetation condition.

Frequency of Sampling

The minimum sampling frequency shall be once every 5 years. There is flexibility in the schedule to enable sampling to focus on similar annual environmental conditions (e.g., preference for sampling post major rainfall events). It may be prudent to seek to sample both a low and high rainfall year early in a sampling program to establish suitable baselines for the range of future environmental conditions. Any clear disturbance events that impact a property, such as broad wildfire or flood, could trigger an additional sampling event. A higher frequency of monitoring may be appropriate for TECs and other high value Sub-assets.

Accurate Stratification

The efficient allocation of both on-ground and remote measurements is a key focus of the Method. The purpose of stratifying projects into Sub-assets and Assessment Units (see Appendix A) and assigning samples within Assessment Units is to reduce uncertainty in estimates of the overall vegetation condition. A stratified sampling approach only works where there are maps that group like features together. Poorly stratified sampling increases the uncertainty of estimates when different vegetation communities, under different management regimes, are pooled together. Experience in rangelands indicates vegetation classification maps are often inaccurate, unlike in areas closer to population centres with potentially greater mapping resources. As a result, the Method allows flexibility to select either an appropriate vegetation map (option 1) or a custom stratification (option 2).

Under the first option, existing vegetation maps (e.g., State-based vegetation maps, NVIS, Land System /Land Type maps etc.) are consulted to establish the range of Sub-assets present on the property including any TECs (similar to the AfN-Method-NV-01).

The second option is to produce a custom, property scale stratification, where Sub-assets are derived from available spatial datasets. For example, satellite imagery may be used to identify existing forest (>2m tall at 20% canopy cover) and potential forest, shrublands, and grasslands (as can be used for stratifying carbon projects) with additional consideration of soil types, terrain and riparian areas.

Sub-assets, regardless of whether they are defined using option 1 or 2, will be further stratified by land management practices to produce Assessment Units. Land management considers any history of clearing, grazing intensity, cropping, historical pasture improvement, and/or fire regimes. There are presently efforts underway to develop a National Land Management Practices Classification System, which may provide a helpful typology once finalised and available.

In both options, the Method prescribes a process of on-ground sampling to verify that the property has been stratified with adequate precision. This verification process is described in Step 6. As a guide, the minimum number of Sub-assets should be defined through considering the number of mapping units equivalent to (for example) Qld Broad Vegetation Groups (BVG), NSW Vegetation Classes or NVIS level 4/5 vegetation types.

The Method is also cognisant of the importance of monitoring of TEC. Where such communities exist on a property, the Method requires that they are assigned to a standalone Sub-asset, although similar TECs may be grouped under a single Sub-asset (e.g. if there are two or more TECs that belong to the same vegetation class).

Reference Condition Benchmarks

The Method provides a range of approaches to developing Reference Condition Benchmarks. The range of approaches are detailed in Section 4.2, and include all options outlined in the Accounting for Nature® Guidelines for Reference Benchmarking.