



## Koala Population and Habitat Method

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# Koala Population and Habitat Method

## Fauna



Title	Koala Population and Habitat Method
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#### Version history

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## 1. Introduction

### 1.1. Aim and Scope of this Method

This Method has been co-developed by Queensland Trust for Nature, Greencollar and Worldwide Fund for Nature Australia. It was developed to assess the condition of Koala (*Phascolarctos cinereus*) presence and habitat quality at the property and project scale in Australia. The Method generates two separate *Econd*<sup>™</sup> scores for a threatened species. Proponents can measure one or both components:

- **Component A:** Koala Population (koala activity, presence and distribution) and
- **Component B:** Koala Habitat (context, extent and connectivity of habitat, threats, food trees and forest structure).

#### Spatial scope

The Method can be implemented within any single Accounting Area greater than 100 ha. It can also be used for any aggregation of Accounting Areas that sum to >100 ha, which comprise multiple projects within a geographically defined area (e.g., sub-bioregion, catchment). If an aggregation is used, all Accounting Areas must occur within the same bioregion as per Interim Biogeographic Regionalisation for Australia (DAWE 2020).

The Method has primarily been developed for Queensland and northern New South Wales. The Method is applicable in other states and territories where suitable koala activity benchmarks are available or can be established following the methodology of Phillips and Callaghan (2011). This Method allows proponents to choose between three confidence levels for their asset account; *very high*, *high*, or *moderate* confidence (Table 1). The *very high confidence* option is intended for proponents with access to relevant ecological expertise. The *high confidence* and *moderate confidence* levels are intended for proponents with less experience or access to relevant ecological expertise.

#### The Koala in south-east Queensland and northern New South Wales

Koala (*Phascolarctos cinereus*) populations across south-east Queensland and New South Wales are declining despite protection measures and recovery actions (Rhodes et al. 2015). Increasing urbanisation reduces the extent of koala habitat. Remaining habitat is affected by fragmentation and reduced quality due to prevalence of dispersal-blocking weeds, invasive predators, and changes to vegetation structure due to altered fire regimes (Lunney et al. 2007). Diseases such as *Chlamydia* interact with habitat degradation to reduce birth-rates and cause early mortality (Rhodes et al. 2009; Polkinghorn et al. 2013). Disease rates are potentially greater in peri-urban populations than in remnant forest (McAlpine et al. 2017). Koala population declines can be abated by protecting large areas of contiguous vegetation where weed, fire and pest management provide suitable habitat quality for self-sustaining populations. Key actions to achieve this include working to restore and connect fragmented habitat and reduce threats within areas of existing habitat.

Koala habitat requirements are complex. The home-range area, preferred food trees, and movement ecology vary geographically. In the coastal areas of south-east Queensland individuals often have territories ranging from 2-10 ha (Goldingay and Dobner 2015; Rhodes et al. 2005). In western and less mesic areas of south-east Queensland, little is known about resident koalas (Davies et al. 2013), but research indicates these koalas use larger patches of habitat, with territories extending from 50-100 ha (FitzGibbon et al. 2017; 2019). Regardless of koala home-range size, dispersal and exploratory movements occur on the ground, where koalas are exposed to predators (especially wild and domestic dogs) or blocked by entangling woody weeds like Lantana (*Lantana camara*).

Food preferences of koala populations and individuals also vary. Local availability and health of food trees (*Eucalyptus* spp.) interact with individual's learned preferences and gut biota to create complex feeding patterns (Australia Koala Foundation 2020). General guides to preferred food trees are available for Local Government Areas (Mitchell 2015). This Method has been designed to be used with the Australian Koala Foundation Koala food tree lists but can also incorporate region-specific data on preferred food trees.

### Limitations

There are several limitations to this Method. *Component A – Koala Population* is based on the Spot Assessment Technique (SAT) (Phillips and Callaghan 2011). This technique uses a scat survey to determine presence/absence, activity levels and distribution of koalas based on a Reference Benchmark. Proponents are required to identify these Reference Benchmarks, which typically vary between vegetation types. However, Reference Benchmarks for Koala activity are not available for all vegetation types and bioregions. To address this, the Method provides guidance to utilise the 'best available' information for these benchmarks, which can be progressively improved as new information becomes available.

*Component B – Koala Habitat* builds upon state-based vegetation assessment frameworks (e.g. BioCondition in Queensland; Eyre et al. 2015) and relies on corresponding Reference Benchmarks for habitat quality. Exotic woody weeds and non-native predators are assumed to be absent in Koala Habitat across Australia prior to colonisation. However, there is the option to set a low threshold for dingo/wild dog abundance (*very high confidence only*).

<b>Purpose</b>	<p>The Method can be used to quantify the condition of two key components relevant to the management of Koalas (<i>Phascolarctos cinereus</i>). These are Component A – Koala Population (activity, presence, and distribution) and Component B - Koala Habitat (habitat quality).</p>
<b>Application</b>	<p>Queensland and northern New South Wales, with scope to expand in future revisions.</p>
<b>Scale</b>	<p>This Method assesses and scores indicators as two separate components: Component A – Koala Population and Component B – Koala Habitat. It uses repeatable and publicly available data sets and published survey protocols, making it comparable across projects and states.</p> <p>It can be used to provide a snapshot in time or a Method for gauging change overtime, with intervention (e.g. before and after management) or without intervention (e.g. monitoring an unmodified area).</p>
<b>Scope</b>	<p>The Method is designed to be implemented on any single property greater than 100 ha, or on any aggregation of numerous projects or properties within a geographically defined area (e.g., sub-bioregion, catchment) summing to &gt;100 ha, providing all component properties/ projects are within the same bioregion (for some examples of application of scale see Appendix G).</p>
<b>Target Audience</b>	<p>This Method has been developed for use by governments, corporations, farmers, producers, Indigenous and private land conservation groups and other landholders.</p>
<b>Decisions to inform</b>	<p>This Method can be used to inform a management of restoration sites for koalas. This may include identifying and guiding restoration efforts to target improvements in indicators based on their relative condition; tracking the recovery or success of restoration for improving koala activity, presence, and distribution or habitat quality; and/or electing to measure koala activity, presence and distribution alone, or koala activity, presence and distribution and habitat quality.</p>
<b>Confidence Level/s</b>	<p>The Method can be applied at very high, high, or moderate confidence levels. The very high confidence level is best suited to proponents with access to ecologists with basic knowledge of tree species in their region and GIS skills. The high and moderate confidence level is best suited to projects delivered by non-experts as data collection is simplified into ordinal scores and uses photo points.</p>

## 1.2. Justification of Confidence Level

The *very high confidence* level is informed by several existing published Methods. These include the Queensland BioCondition Method (Eyre et al. 2015), the SAT protocol (Phillips and Callaghan 2011) and Reference Benchmarks of presence/occupancy and activity based on preferred habitat trees. Koala research is primarily available for coastal areas, meaning certainty around activity/occupancy rates for drier systems may be less accurate. To account for this, a widevariance for metrics within Component A – Koala Population (activity) has been given, and future revisions aim to integrate evidence and refine estimates of activity levels as it comes available.

The *high* and *moderate* confidence level report on the same indicators but are more accessible and efficient for those without ecological expertise. The method relies on easily accessible data for non-experts (Queensland Globe or similar in other states, photo points and scat searches) and converting that information into an ordinal score. The reliance on ordinal scoring reduces the precision of the output, as does the less accurate data collection Methods, thus the confidence level for this tier is reduced.

## 1.3. What an Environmental account looks like

The *Accounting for Nature*<sup>®</sup> Framework requires accounts to be comprised of four components for them to be certified:

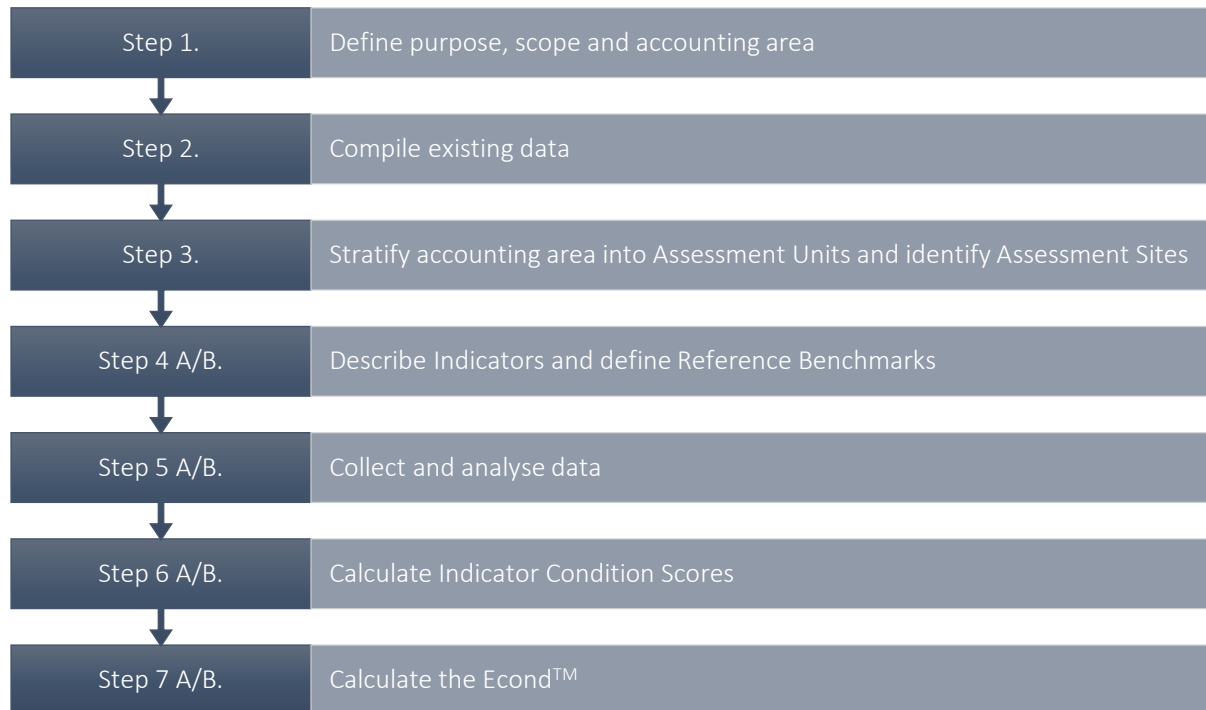
1. An **Environmental Account Summary** – a public document that summarises the results of the environmental account in a form that is readily communicated to the public.
2. An **Information Statement** – describes in detail the method used and the actions taken to address each of the eight steps under the framework including rationale behind asset selection, choice of indicators, Method used, analysis and management of data and calculation of the Econd<sup>™</sup>.
3. The **Environmental Account** – a database (such as an excel file) that contains all the data described in Asset Tables, Data Tables, and Balance Sheets.
4. An **Audit Report** – an independent report that is completed by an AfN Accredited Auditor, that verifies the Account was prepared in accordance with the approved Methods, the *AfN Standard* and AfN Audit rules.

Upon certification of the account, the Environmental Account Summary and Information Statement will be published on the AfN Environmental Account Certification Registry.



## 1.4. Overview of Process

This method includes the following seven steps:



*N.B. All accounts should complete Steps 1-3. Steps 4-7A correspond to Component A – Koala Population, while Steps 4-7B correspond to Component B – Koala Habitat.*

## 2. Creating the Environmental Account

### Step 1. Define purpose, scope, and accounting area

The preliminary step to developing an Environmental Account is to **describe** the Environmental Account through defining its intended **purpose, scope** and **accounting area**.

**Purpose:** Describe the specific purpose of the account.

**Scope:** Describe the scope of the account.

- *Snapshot* – a one-off assessment of condition of Native Vegetation
- *Change over time* – an ongoing assessment of the change of environmental condition through time
- *Cause of change* – determine how the impacts of management activities change the condition of environmental assets, either at a point of time or through time.

**Accounting Area:** Describe the Accounting Area (include location and size details). Provide a map of the Accounting Area that shows location and size information. This Method is designed to be used within an area defined by the person constructing the account. Pivotal to allocating the number of Assessment Sites, constructing the baselines and indicators is setting an Accounting Area. By the completion of this step, you will have a polygon on a map with a known area (in hectares) if you are using the *very high confidence* level, or a map of your Accounting Area and where you will sample for the *high confidence* level and *moderate confidence* level.

For all confidence levels, the first step is to set the geographical bounds of the account; locate the site you are constructing your account for. The Method works best if this is a unitat which management is being impacted. Some examples include:

- Your project is working with a landholder to assess and improve koala habitat on their property. In this case, the landholder’s bounds of management are the limit. In most cases the property boundary will become the Accounting Area. A polygon for this is available using the relevant cadastre spatial layer for the state.
- You are assessing the quality of koala habitat within a National Park or forest. You have resources to assess the entirety of the protected area, so the Accounting Area is the extent of the protected area
- You are assessing the quality of koala habitat within a large, protected area estate or property, but management is only being applied to a sub-section of that and your access to resources is limited. The Accounting

Area will be the area where management will create impacts for koalas.  
You will need to identify a polygon yourself.

*N.B. Ensure the Accounting Area polygon excludes areas that will not be impacted by conservation management, such as permanent or planned infrastructure areas that are not relevant that will not change in condition for the life of the Account.*

Further recommendations for setting your Accounting Area include:

- We recommend incorporating the diversity of clearing histories present. For example, a property Accounting Area may comprise remnant, regrowth and cleared areas. You may be planting trees within the cleared area, controlling weeds in the mature regrowth, and undertaking no management in the remnant vegetation. By including all three clearing histories, you are summarising the current quality of existing habitat as well as creating a baseline to measure changes in your restoration areas over time. Your Asset Account will therefore summarise the quality of koala habitat on your property but allow you to interrogate each Sub-asset vegetation type.
- The Method has been designed to allow large scale comparisons across and between Accounting Areas. For example, you are a local government officer supporting numerous landholders to improve koala populations. This Method allows you to set an Accounting Area for each site (most likely, numerous properties for landholders), then sum these to your larger project's extent (for example, summarise koala habitat quality across your LGA). Your project will have a portfolio of Asset Accounts using the same confidence level, each with their own Accounting Area but summarised into a single, overall Asset Account and Accounting Area.

**Very high and high confidence:** If you are constructing a *very high confidence* koala asset account, we recommend also constructing a level 1 confidence Native Vegetation Method such as AfN-PROP-NV-01 (Butler 2020). Many indicators are transferrable or are collected using similar processes. We recommend using ArcGIS (ESRI) as the spatial database for your account. The ArcGIS training portal has guidance on the steps needed to set your Accounting Area in their 'Introduction to editing tutorial'<sup>1</sup>. Set your Accounting Area by creating a new polygon that describes the site. This can be clipped from a Cadastre data set or drawn as a new element in your map.

**Moderate confidence:** your Accounting Area is the bounds of your property. It will be useful to have a map of your property, its location in the context of your surrounding area and its total size in hectares. We recommend using ArcGIS (ESRI) as the spatial database for the Account, or state mapping platforms such as Queensland Globe (Queensland) or SEED (NSW).



*N.B. The accounting area must stay the same for the lifespan of the account. If the accounting area changes (such as a new area to be added, or an area to be removed), then a new account must be developed, or the account, 're-set' and started again with the new accounting area.*

#### Output of Step 1

- A description of the accounting area including **location** and **size**
- A table describing the **purpose** and **scope** of the account
- A **map** showing the accounting area

## Step 2. Compile existing data

### Data collection

#### *Moderate confidence*

Obtain a map that defines the boundaries of your Accounting Area. This is likely to be a map that shows the boundaries of your property, including the area (in hectares). Progress to Step 3.

#### *Very high and high confidence*

Collate relevant spatial layers and reports including:

- Spatial layers of the pre-clearing vegetation within the Accounting Area.
- Spatial layers of current vegetation class or status (cleared, regrowth, remnant) within the Accounting Area. Ensure you have a dataset that differentiates the non-remnant component into regrowth and cleared.
- A vegetation community (Regional Ecosystems or Plant Community Types) report for your Accounting Area.
- Food tree lists for koala populations in your area based on the Australian Koala Foundation list (Mitchell 2015), local knowledge and other peer-reviewed literature.
- Floristic descriptions and benchmarks for vegetation types within the Accounting Area. If they are not available, work with the relevant vegetation mapping authority to construct one.

Most information should be readily available via spatial databases and state government environment department websites (Appendix B). Local Landcare, regional NRM groups, or state herbaria or environment departments may be able to provide additional guidance.

*N.B. As per Butler (2020), ensure all spatial data files are saved in formats compatible with Geographical Information Systems, such as a shapefile, and in a commonly applied datum such as the Geographic Datum of Australia 1994, Geographic Datum of Australia 2020 or the Map Grid of Australia (1994 or 2020, including specified zone).*

### Identify the Sub-assets within the Accounting Area

Different vegetation types and different classes of vegetation provide variable koala habitat quality. In this Method, Sub-assets are defined by the different vegetation types within the Accounting Area. To construct the map of your Sub-assets in your Accounting Area:

- In a GIS, display your pre-clearing vegetation layer. Clip this to the extent of your Accounting Area.
- For a *high confidence level* account, you will have a single Sub-asset that includes all vegetation types on this layer.
- For a *very high confidence level* account, you should identify the different vegetation types present in your Accounting Area. Where sensible, group similar vegetation types. These broad vegetation groups will be your Sub-assets.
- Calculate the area occupied by each Sub-asset.

- Create a short and easily understood description of your Sub-asset. For example, a Sub-asset comprised of Queensland Regional Ecosystem 12.3.3, or both RE 12.3.3 and 12.3.7 could be described as 'Queensland Bluegum flats'.
- Attach a link to the relevant benchmark and technical description for the Sub-asset. For sub-assets that comprise multiple vegetation types, include descriptions for all, where available.

*N.B. We recommend omitting Sub-assets (vegetation types) that are unlikely to be used by koalas from your Accounting Area. For example, naturally treeless grasslands, or forests that do not contain koala food trees (as defined in the floristic description), such as rainforests. This is likely to require expert judgement. If any Sub-assets (and their component vegetation types) are excluded from the Accounting Area, provide a justification. For example, an area of semi-evergreen vine thicket of RE 8.11.12 was excluded because it is not preferred koala habitat. Ensure that you re-define the bounds of your Accounting Area polygon.*

#### Output of Step 2

##### *All confidence levels*

- Accounting Area map

##### *High and very high confidence*

- Polygon features defining your Sub-asset within the Accounting Area

##### *Very high confidence*

- A table listing vegetation types within the Accounting Area, along with their descriptions

##### *Component B – Koala Habitat*

- Floristic descriptions and Reference Benchmarks for vegetation attributes for vegetation types within the Accounting Area

### Step 3. Stratify the Accounting Area and identify Assessment Sites

#### Stratify the accounting area

The process of dividing the Accounting Area (or the Sub-assets within the Accounting Area for *high* and *very high* confidence only) into >1 Assessment Units is referred to as stratification. In this Method the level of stratification is determined by the confidence level for the account (Table 1; Figure 1, Appendix G). Assessment Units are a combination of each Sub-asset (broad vegetation type, i.e. Regional Ecosystem) and their respective clearing history class (i.e. remnant, mature regrowth and cleared). For each Sub-asset, you may have up to three different clearing history classes.

#### *Assigning Assessment Units – high and very high confidence ONLY*

- Display the pre-clear vegetation shapefile that defines your Sub-assets
- Display the vegetation class mapping (remnant, regrowth and cleared) and clip this to the Accounting Area.
- Intersect your Sub-asset spatial layer (pre-clear vegetation) with the vegetation clearing history class layer to generate a set of unique polygons – each Sub-asset (broad vegetation type) and its respective clearing history. These will be your Assessment Units.
- Collate an attribute table that clearly sets out the Sub-asset, a description of the Sub-asset, its component Assessment Units and the corresponding hectare values. Each Assessment Unit should have a unique identifying code:
  - o *High confidence*: AUa = remnant, AUb = regrowth, AUc = cleared.
  - o *Very high confidence*: AU16a = Open eucalypt forest - remnant, AU16b = Open eucalypt forest – regrowth, AU16c = Open eucalypt forest – cleared.
- Complete sheet S01 in the Excel workbook (Appendix H).

Assessment Units can be composed of multiple isolated areas but all should be generally larger than one hectare. If your stratification yields Assessment Units <1 ha or <5% of the Accounting Area, consider whether you can merge similar vegetation types in Step 2 – when defining Sub-assets. Ensure the aggregated area of merged polygons does not exceed 10% of the Accounting Area.

*N.B. You can use historical or current aerial imagery to validate the accuracy of clearing history spatial layers and refine polygon boundaries for mature regrowth and remnant as necessary.*

*Table 1. Relationship between Sub-assets and Assessment units for each confidence level.*

Confidence level	Sub-assets	Assessment units
Moderate	The Accounting Area is considered as a single Sub-asset.	The Accounting Area is considered as a single Assessment Unit.
High	The Accounting Area comprises a single Sub-asset – Koala vegetation.	Assessment Units are defined by unique clearing history classes.
Very high	Sub-assets are defined by the different vegetation types within the Accounting Area.	Assessment Units are represented by the different clearing history (remnant, regrowth and cleared) within each Sub-asset.

## Select Assessment Sites

Allocate Assessment Sites within each Assessment Unit based on the minimum requirements in Table 2. Where possible, the spatial location of Assessment sites should be randomly generated, be separated by >100 m and be located >25 m from infrastructure or transition zones (ecotones) between Assessment Units.

Table 2. Minimum number of Assessment Sites per Assessment Unit based on area.

Assessment Unit area (ha)	Minimum number of Assessment Sites
1-2	1 (Preferably merge into another Assessment Unit)
>2 and ≤20	3
>20 and ≤60	5
>60 and ≤500	7
>500	9

### Additional steps - Very high and high confidence ONLY

Determine the location of your Assessment Sites by:

- Randomly generate the location for your Assessment Sites using a Geographic Information System. Following Butler (2020), Assessment Sites should be based on the random selection of intersections in a grid overlaid on each Assessment Unit (see Appendix A). If you are constructing a Native Vegetation account the sites can be the same in the Koala account.
- For Component B, set the start and end points of the Assessment Sites (i.e. a 100 m transect) to ensure the direction of the transect is along a slope, not down it.
- Add the GPS points and Assessment Site labels into the relevant spreadsheet tab 'Data\_table'
- Export a map of your Assessment Sites.

### Output of Step 3

- A map and table showing the **stratification** of the Accounting Area into one or more Assessment Units
- A table with the extent (ha) of each Assessment Unit
- A map and table with the coordinates of each **Assessment Site** within the Accounting Area.





[insert map]

*Figure 1. Examples of stratification in a moderate confidence level account (top, left), a high confidence level account (bottom, left) and a very high confidence level account (right). The moderate is unstratified, the high is stratified by clearing history, and the high is stratified by the vegetation type and clearing history.*

# Component A: Koala Population

## Step 4. A. Describe environmental indicators and determine reference benchmarks

### Indicators

#### *Koala activity*

The Koala activity indicator describes whether koalas are present and their activity levels. Koala activity is captured using the Spot Assessment Technique, which provides an indication of population condition (Phillips and Callaghan 2011). Koala activity is measured as the proportion of trees sampled at each site where koalas are recorded as present (i.e. presence of a koala scat). This Method uses SAT as it is a widely accepted method (see Section 4) and is accessible for land managers due to its relative cost-effectiveness. All confidence levels use the same protocol.

#### *Potential complementary approaches*

There are a number of additional approaches to detecting koalas that could be used to complement the SAT survey. These approaches can be used to calibrate the SAT survey data.

- Detection dogs can be up to 150% more accurate and 20 times quicker than humans at locating koala scat (Cristescu et al. 2015). In this Method, detection dogs could be used alongside SAT to calibrate the activity level measured by humans. That is, to identify the difference in detection rates, and thus the proportion of detections missed by humans in the Accounting Area, or similar.
- The experience of observers has a significant impact on direct detection and counts of live koalas in the field (Phillips and Callaghan 2011). This Method is based on SAT, which addresses this bias. As with detection dogs, the observation and counting of live koalas by experts can provide a relational measure of the SAT activity score to observed density of individuals on site.
- Identification of koala home ranges and population densities cannot be determined from SAT. This requires direct survey (i.e. with detection dogs, collaring and GPS tracking). Although this is beyond the scope of this method, it can be undertaken to complement this Method by providing proponents information that can assist in determining management actions.

### Reference Benchmarks

Reference condition benchmarks for Koala Activity Levels can be established from: (a) published data; or, (b) derived independently from data collected at sites that are representative of the asset or sub-asset in its undegraded state (i.e. reference condition sites); or, (c) a combination of both. For the location and sampling design for reference condition sites, it is recommended that proponents seek advice from relevant government agencies that are responsible for curating information on reference benchmarks or follow published state or territory guidelines (e.g. Eyre et al. 2017).

### *Limitations to Reference Benchmarks for Koala activity*

Limited data is currently available to inform Reference Benchmarks for this indicator. Information that can be used to inform benchmarks is primarily described by Phillips and Callaghan (2011) who provide benchmarks of koala activity but these have large granularity – they are set at Broad Vegetation Group equivalent scales – wet Eucalypt forests of the coastal east vs. dry open Eucalypt forests west of the range, and some non-Eucalyptus dominated areas around central New South Wales. The forest type, its local context and the representation of different food trees impact the suitability, and maximum range size, needed for each koala. This, in turn, impacts population density and therefore the density and abundance of indirect signs as scats. Unfortunately, there is not sufficient data to adjust the thresholds of activity within Phillips and Callaghan (2011) to a higher level of granularity (i.e. Queensland Regional Ecosystems or in New South Wales Plant Community Types). However, some evidence is available for south-east Queensland that provides an indication of koala habitat carrying capacity for regional ecosystems in Ipswich (Bussey & Ellis, 2016).

An illustrative example of using published data to establish Reference Benchmarks for Koala Activity Levels is provided below:

- Determine the Phillips and Callaghan (2011) area/population density category that best matches the geographic location of the Accounting Area (east coast, western plains) and the capacity of vegetation types within Assessment Units to support koala populations (high, medium, low), (e.g. Appendix E) (Bussey and Ellis 2016; Phillips and Callaghan 2011).
- Identify the upper estimate of medium use reported for the relevant area/population density category and assign as the Reference Benchmark for the Assessment Unit.

#### Output of Step 4a

- A table describing the **environmental indicators** to be measured in the account
- A table that includes the **Reference Benchmark value** for each indicator for each sub-asset.

## Step 5. A. Collect and analyse data

A field equipment list is provided in Appendix D. Complete the following steps at each Assessment Site within your Accounting Area:

- Locate and mark the centre tree and search area with flagging tape. A tree is defined as a live woody stem of any plant species (excepting palms, cycads, tree ferns and grass trees) which has a diameter at breast height (DBH) of 10 cm or greater. The centre tree can be selected as the centre-most tree of the Assessment Site, or following Phillips and Callaghan (2011): (i) a tree of any species beneath which one or more koala scats have been observed, and/or (ii) a tree in which a koala has been observed, and/or (iii) any other tree considered to be potentially important for koalas, such as a food tree.
- Mark your maximum search area with flagging tape. This is defined as a 50 x 50 m area (square) around your centre tree. Use a 50 m measuring tape as a guide.
- Return to your centre tree. Record your GPS coordinates onto your data form, along with the tree species and DBH.
- Begin by searching the centre tree. A tree search consists of a two-minute search for koala scat within 1 m of the base of the tree. The time limit ensures consistent search effort within and between Assessment Sites. You can divide the base area of the tree into quarters to ensure you evenly allocate your search time (i.e. 30 seconds per quarter). The search stops after 2 minutes, or when a scat is found (whichever comes first).
- Record the result on your data form (positive or negative).
- Repeat tree searches for the 29 nearest trees, ensuring you stay within the maximum search area. This is important in cleared or modified landscapes, where you may need to traverse large distances to find 30 trees. If you cannot find 30 trees within this area, terminate your survey once you have searched all suitable trees within the search area.

*N.B. Where there is sufficient knowledge of preferred koala tree species, the rapid-SAT protocol (Phillips and Wallis 2016, Phillips et al. 2021) may be applied. This approach can reduce the number of trees that are sampled when the likelihood of koala presence is low. Rapid SAT involves searching the closest 7 highly preferred tree species closest to the centre tree. If no scat is found, the search is discontinued, and the site scores a 0 for activity level. If a scat is found, it is marked as present and a full SAT is completed. That is, identify, uniquely mark and search a total of 29 nearest trees to the centre tree.*

### Output of Step 5a.

- A **data table** (e.g. a spreadsheet) containing all the raw data for each environmental indicator for each Assessment Site.

## Step 6. A. Calculate Indicator Condition Scores

### Calculating Assessment Site condition scores

Observed Koala Activity Level (KAL) at each Assessment Site is estimated as the percentage of trees with evidence of koala activity (i.e. scats). Each KAL estimate at an Assessment Site is expressed as a percentage of the relevant Reference Benchmark. The percentage of Reference Benchmark is then converted to an indicator condition score (ICS) using a continuous scoring schema. The indicator condition score (ICS) is a standardised value of an indicator measure against the Reference Benchmark, on a scale of 0 to 100. This Method penalises both low activity and high activity. This is because low activity is likely to reflect poor koala habitat, while a KAL that is too high may reflect an overabundance of koalas, which has negative consequences for both koalas and their habitat (Whisson and Ashman 2019; Appendix C).

To calculate the ICS for each Assessment Site:

- Express the Assessment Unit KAL(s) as a percentage of the Reference Benchmark (divide the KAL by the Reference Benchmark and multiply by 100)
- Convert the percentage value into an ICS value using the logic in Table 3.

Table 3. Koala activity level (KAL) Reference Benchmark and ICS calculation. *P* = Percentage of Reference Benchmark.

KAL % of Reference Benchmark	ICS value calculation
≤100	<i>P</i>
>100 and ≤200	100
>200 and ≤500	$100 - (P - 200) / 3$
>500	0

**EXAMPLE:** The Reference Benchmark for KAL is 32. The estimate from the Assessment Site is 20. The percentage of Reference Benchmark is 63 (20 divided by 32 multiplied by 100). As *P* is less than 100, the indicator condition score is 63.

Indicator Condition scores for Assessment Sites should be recorded within a Data Table (as in Table 4).

Table 4. Example data table for KAL withing Assessment Units.

Sub- asset	Clearing history class	AU	AS	RB	KAL	No. of trees	No. Of trees active	KAL % RB	ICS

#### Output of Step 6a.

- A **Data Table** (e.g. a spreadsheet) containing all the data (including calculated Indicator Condition Scores)

### Step 7. A. 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™ (overall condition score that has been spatially-weighted) is calculated for all Sub-assets within the Accounting Area. To calculate the Econd™:

- calculate the average condition score of Assessment Sites within each Assessment Unit and calculating the area-weighted average of Assessment Units within each Sub-asset; and then,
- calculate the area-weighted average of Sub-assets within the Accounting Area (i.e. overall
- condition score or Econd™). Record your data in a format similar to Table 5 and Table 6.

Table 5. Example table. Condition of Assessment Units within Sub-assets.

Sub-asset	Clearing history class	Assessment Unit	Sub- asset area (ha)	Percent of sub- asset by area	Number of Assessment Sites	Indicator condition score (mean)

Table 6. Example table. Condition of sub-assets within the Accounting Area and overall condition of asset.

Sub-asset	Short description	Present in Assessment Units	Asset area (ha)	Percent of Accounting Area	Econd™
		List relevant Assessment Units			

#### Output of Step 7a

- A **data table** (e.g. a spreadsheet) containing all the raw data for each indicator for each Assessment Unit, including the calculations for the ICS and Econd™.
- A **summary table** showing the Econd™ scores.

# Component B: Koala Habitat

## Step 4. B. Describe environmental indicators and determine Reference Benchmarks

### Indicators

There are three indicators that comprise the Koala Habitat component of the Method. An Indicator Condition Score will be calculated for each Indicator.

#### *Context, extent and connectivity*

This indicator captures where the Assessment Unit sits within the broader landscape. It quantifies the extent (area) of habitat and how it connects to nearby patches of remnant vegetation.

- *Very high confidence* uses the BioCondition Method (Eyre et al. 2015) for quantifying the patchiness and connectivity of native remnant and mature regrowth vegetation in an area. Proximity to urban areas and roads is also measured.
- *High confidence* uses online mapping tools (e.g. Queensland Globe in Queensland or SEED in NSW) and an ordinal scoring system.
- *Moderate confidence* methods are unavailable.

#### *Habitat quality*

This indicator measures the quality of the vegetation within the Accounting Area as habitat for koala. This includes the diversity of food trees, the number of large habitat trees, evidence of recruitment of koala food trees and vegetation structure.

- *Very high confidence accounts* use a complementary sub-set of Methods within the BioCondition Method (Eyre et al. 2015) modified to address koala food and habitat trees. It considers the four core elements of vegetation compared to the Regional Ecosystem benchmark specific to that Regional Ecosystem.
- *High and moderate confidence accounts* use a set of ordinal scoring categories and a photo monitoring point at each Assessment Site.

#### *Prevalence of threats*

This indicator measures three key threats (sub-indicators) to the koala as identified in the Recovery Plan (Department of Agriculture, Water and the Environment 2022). These threats can be managed at the scale of an Accounting Area and are easily monitored through time or as a snapshot (single point in time). The threats include the presence and activity levels of non-native carnivores, the presence and density of non-native weeds (including native species outside their natural range) in the shrub layer and the threat of vehicle strike (proximity to urban areas and sealed roads).

- *Very high confidence:* Bi-annual camera trapping to assess the presence and relative activity index of non-native carnivores, the BioCondition Method (Eyre et al. 2015) for quantifying non-native shrub cover, and spatial GIS layers to identify threats from vehicle strike.
- *High and moderate confidence:* Anecdotal observation for all three indicators.

## Reference Benchmarks (Very High confidence only)

For *very high confidence* accounts, proponents must set the reference benchmark condition in the Excel Workbook. Proponents should generate their own Reference benchmarks based on the rules below. By default, the Reference benchmark condition is the pre-colonial condition. This should be completed prior to undertaking the field component (Step 5b) of the Method.

### *Context, extent and connectivity*

The Reference Benchmark for this indicator assumes the pre-colonial landscape comprised intact vegetation (i.e. un-cleared and un-modified by clearing). This means the context, extent and connectivity of koala habitat is defined by pre-clear vegetation mapping.

### *Habitat quality*

All states apart from Western Australia and Northern Territory have published vegetation condition benchmarks that correspond to their vegetation community mapping. These are used as Reference Benchmarks for *Habitat quality* (see Appendix B). In the absence of published Reference Benchmarks, the state government (e.g. Herbaria), local NRM or Landcare groups can be consulted for draft or unpublished Reference Benchmarks. Otherwise, proponents will need to construct a data-justified equivalent. The Habitat quality indicator comprises several sub-indicators:

### *Koala food tree diversity*

The total richness of food tree species available for koalas in any Regional Ecosystem or vegetation type is determined by counting the number of species in the relevant koala food tree list (Mitchell 2015) with the vegetation Reference Benchmark document. This should be augmented with evidence from local research or other sources where available.

**EXAMPLE:** I am in the Ipswich City LGA of Queensland and determining the Reference Benchmark value for Koala food tree diversity in Regional Ecosystem 12.3.3. Looking across both lists, I see that *Eucalyptus tereticornis* is a preferred tree in my region that is on the technical description list. *Eucalyptus moluccana* may be at my site as a lower preference tree. I have evidence from local studies that koalas in my region eat *Corymbiacitriodora* and *E. crebra*. My Reference Benchmark for Koala food tree diversity is 4 species.

### *Number of large habitat trees*

This indicator considers any large tree as habitat for koalas, regardless of whether it is a food tree. A 'large tree' is defined differently depending on the vegetation type, as is the Reference Benchmark for the density of large trees. In Queensland, the threshold for a 'large tree' is set out in the corresponding Regional Ecosystem Reference Benchmarks. A similar process can be applied in NSW, or a justified on the basis of a similar Regional Ecosystem in Queensland.

**EXAMPLE:** At the same site in Ipswich the large tree Reference Benchmark threshold is 47 cm DBH with 24 large trees per hectare. Therefore, the benchmark is 24 trees of *Eucalyptus* spp. >47 cm DBH per hectare.



### *Age structure of koala food trees*

This indicator assumes that, pre-colonisation, all Regional Ecosystems had continual recruitment of koala food trees. This would mean each koala food tree species was present in each age class structure layer. Age class structure layers are grouped by size and height as shown in Table 7.

**EXAMPLE:** At the same site in Ipswich the technical description describes the koala food trees in stratum T1, T2 and T3, alongside a relative stem density. I use the cover of each food tree species to calculate how many stems per hectare there should be in each strata (see Appendix F).

*Table 7. Description of age structure of koala food trees categories.*

Description	Size/height	Code
Young recruits	><2 m tall and <10 cm DBH	REC
Almost utilisable trees	>2 m tall and <10 cm DBH	EREC
Early utilisable trees	>2 m tall and >10 cm DBH	LREC
Mature recruit	>2 m tall and >10 cm DBH; <large tree	MAT
Large habitat trees	> large tree threshold	LRG

### *Evidence of recruitment*

This indicator assumes that management of forests by Indigenous people and non-human processes would have ensured continual recruitment of koala food trees. Therefore, each mature koala food tree should have evidence of recruitment. The Reference Benchmark for this indicator is determined by the diversity (species richness) of koala food trees as determined in the sub-indicator for *Koala food tree diversity*.

**EXAMPLE:** At the same site in Ipswich we determined there were four koala food tree species. So the benchmark condition is that there is evidence of recruitment of all 4 species, i.e. 100% of canopy trees are recruiting.

### *Cover of non-native (including native species outside their natural range) shrubs*

The benchmark condition for this indicator assumes that none of the invasive shrubs that are listed under State or Federal invasive species lists (or you have evidence they inhibit koala dispersal) were present on the Australian continent.

### *Prevalence of threats*

The benchmark condition for threats including non-native predators is considered to be the pre-colonial state. This means non-native predators were absent in the landscape. However, there is the option to set a low threshold for dingo/wild dog abundance. We recommend maintaining a low presence of dingo/wild dog in the landscape, and thus they are the only species with a non-zero benchmark.

#### **Output of Step 4b**

- A table describing the **environmental indicators** to be measured in the account
- A table that includes the **Reference Benchmark value** for each indicator for each asset or sub-asset/s.

## Step 5. B. Collect and analyse data

The following section describes the process for data collection, scoring indicators and analysis for each confidence level.

### Desktop data analysis

The following analysis should be undertaken on a desktop prior to collecting field data. Scores should be obtained for the following indicators:

Moderate confidence: Not applicable

#### High confidence

- Landscape level indicators scored according to the parameters in Table 6 and Figure 2.

#### Very high confidence

- Context, extent and connectivity
- Proximity to urban areas
  - o In a GIS, draw a circular buffer with a 20 km radius from the centre of the Assessment Site.
  - o Identify the percentage of the buffer area (excluding the Accounting Area) that is mapped by urban land uses in the relevant land use mapping spatial layer.
  - o Enter the data into the Excel workbook, 'sheet S03\_Calculator\_Threats'
- Proximity to sealed roads
  - o In a GIS, calculate the number of major and minor arterial roads within 20 km of the Accounting Area based on relevant state government road layers
  - o Enter the data into the Excel workbook, 'sheet S03\_Calculator\_Threats'

Table 6: Scoring of landscape level Indicators and attributes for a high confidence level account,.

Score	Extent and connectivity		Prevalence of threats – landscape level	
	Extent (ha)	Connectivity (per Figure 2)	Proximity to urban areas (km)	Proximity to sealed road (m)
1	<5	Isolated	<1	<50
2	6-20	NA	1-20	50-100
3	21-30	NA	21-50	101-500
4	31-100	NA	51-100	501-5000
5	>101	Connected	>101	>5000

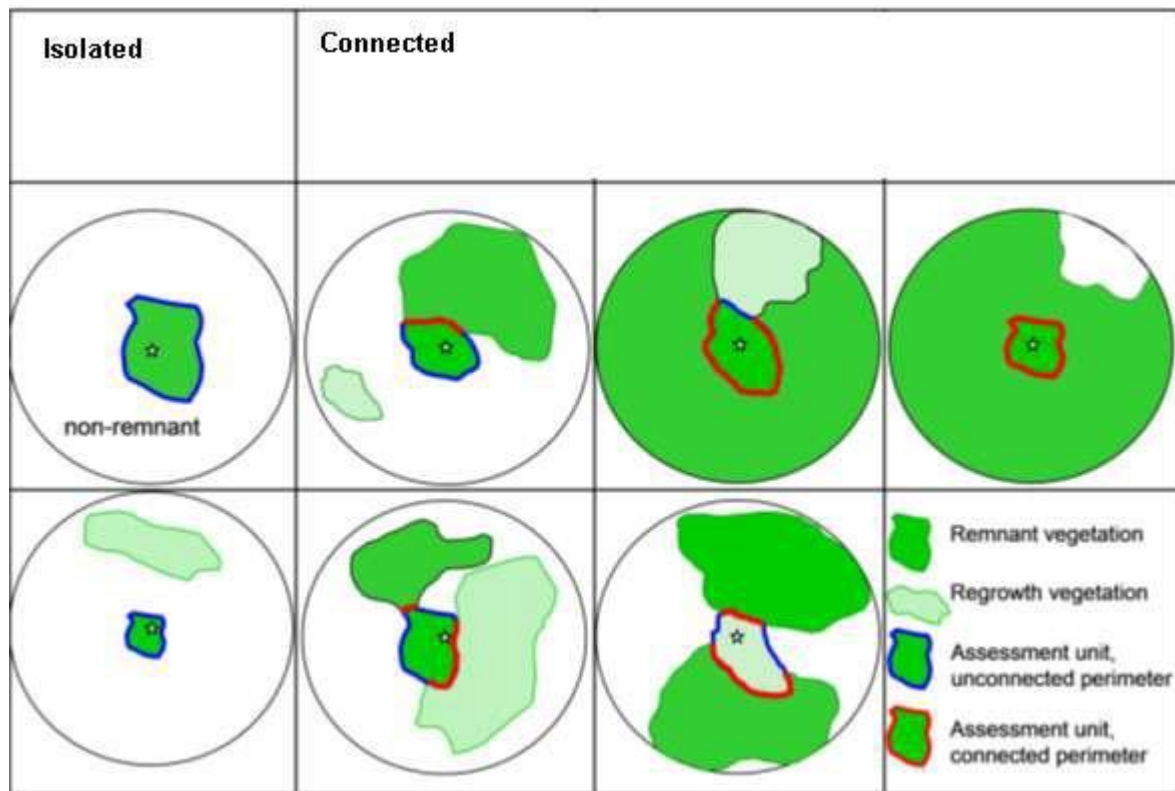


Figure 2. Connectivity scoring diagram for high and very high confidence level accounts (sourced from Eyre et al 2015).

### Field survey (moderate and high confidence level)

A field equipment list is provided in Appendix D. The following section details the steps required for data collection for each indicator.

#### Habitat quality (moderate and high confidence level account)

The survey method for the Habitat quality indicator is adapted from the Accounting for Nature® Landcare Farming Native Vegetation Accredited Method (Elmer 2021):

- Navigate to your Assessment Site.
- Mark your site to ensure comparable results over time.
- Install your star picket at the centre of your site. Use marking paint to ensure it is visible.
- Label the picket with the Assessment Unit number (e.g. AU1.1 and a C for 'centre').
- Run a 10 m tape due south from the centre star picket (Figure 3). Install a second picket here. Take the following photographs (with no zoom and no wide-angle) at each north and south star picket. Ensure they are clearly labelled for reference:
  - o Canopy photo: place the camera on the star picket and take a photo straight upwards through the canopy (example photo label: AU1.1\_C);
  - o Four landscape photos: Rest the camera horizontally on the top of the star picket and position the camera so that the horizon cuts the photo frame in half (half above the horizon and half below). Take the photo focusing on infinity. Do this for

landscape photos in a north, east, south, and west direction in a clockwise direction (with the aid of a compass). Label each photo (example photo label: AU1.1\_N);

- One ground-cover photo: While holding the camera above the central star picket, point the camera south with landscape orientation along the tape measure so that the 1 m mark is in the centre of the photo (example photo label: AU1.1\_GC).
- Assign a score for each attribute shown in Table 7. Record this on your data sheet.

*N.B. It is highly recommended that a copy of the previous monitoring photos is taken on each subsequent photo-monitoring round to help align new photos with previous photos to ensure consistency.*

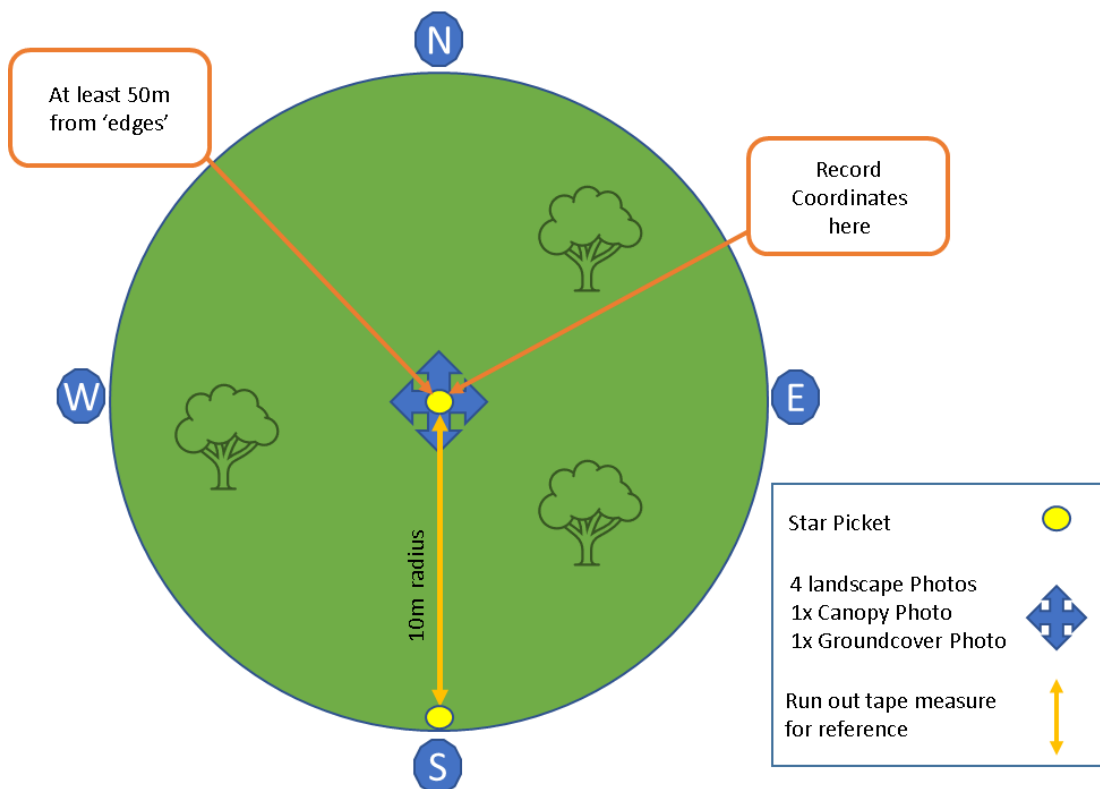


Figure 3. Diagram of the permanent monitoring sites to be established at each Assessment Site. Assessment Sites should be established at least 50 m from an 'edge'.

Table 7: Attributes for field data collection and criteria for scoring.

Score	Evidence of pests	Usable trees (>10 cm DBH within 10 m)	Average tree heights	Recruitment (<10 cm DBH)	Non-native weeds
1	Present	Not present	N/A	Not present	Head-high
2	N/A	1	<10 m	1-4	Shoulder-high
3	N/A	2-5	>10 – 15 m	5-6	Hip-high
4	N/A	6-10	>15 – 20 m	7-9	>10%
5	Not present	>10	>20 m	>9	<10%

### Field survey (*very high confidence level only*)

A field equipment list is provided in Appendix D. The following section details the steps required for data collection for each indicator.

#### *Habitat quality*

- Set out a 100 m transect in a straight line.
- Measure *Canopy Cover*, *Non-native Shrub Cover* following the BioCondition manual (Eyre et al. 2015). If a 100 m line-intercept transect cannot fit within the Assessment Unit, it is acceptable to survey multiple shorter transects that combine to a total of 100 m (i.e. 2 x 50 m transects) (Butler 2020). Following Butler (2020), where tree canopy cover is greater than 70%, the line intercept transect may be shortened to 50 m.
- Determine the threshold that defines a '*large tree*' from the Reference Benchmark. Count the number of large trees within the 50 x 100 m transect.
- Record the *Recruitment of dominant canopy species* according to the Reference Benchmark within the 50 x 100 m transect. This should be a presence/absence for each species in the emergent, canopy and subcanopy layers (Eyre et al. 2015).
- Determine the *koala food tree age class structure* of koala food trees. Select two 25 x 25 m plots within the 50 x 100 m transect. Within each plot, count the stems of koala food trees you identified in your Reference Benchmark within each of the age structures (LRG, MAT, LREC, EREC, REC; see Table 11). Calculate the average of the two replicates to generate the age structure frequency for your Assessment Site.

*N.B. It can be helpful to divide the 100 x 50 m transect into eight 25 x 25 m blocks to count the presence/absence of all tree species and the koala food tree age class structure indicators.*

*N.B. If you are also completing a LRF Native Vegetation (Butler 2020) asset account for this site, the data for canopy cover, non-native shrub cover, large trees and recruitment in the Ecologically Dominant Layer (EDL) indicator data are transferable. However, ensure you also complete the step for Koala food tree age class structure.*

Table 8. Indicator description scores for number of koala food trees (adapted from Eyre et al. 2015).

Indicator description	Score
<25% of benchmark number of koala food tree species present	0
≥25% to 90% of benchmark number of koala food tree species present	2.5
≥90% of benchmark number of koala food tree species present	5

Table 9. Indicator description scores for number of large habitat trees (adapted from Eyre et al. 2015).

Indicator description	Score
No large trees present	0
0 to 50% of benchmark number of large trees	5
≥50% to 100% of benchmark number of large trees	10
≥ benchmark number of large trees	15

Table 10. Indicator description scores for age structure of koala food trees.

Indicator description	Score
≤1 age class present; T1 or large trees absent	1
≤3 age classes present; T1 or large trees present	2
4 age classes present; T1 or large trees present	3
4 age classes present; but does not meet score 5	4
4 age classes present; ≥10 trees large trees; 30-50% of stems in T1, 10-20% of stems in T2 and T3; evidence of recruitment	5

Table 11. Indicator description scores for evidence of recruitment (adapted from Eyre et al. 2015).

Indicator description	Score
<20% of koala food tree species present as regeneration	0
≥20 – 75% of koala food tree species present as regeneration	3
≥75% of koala food tree species present as regeneration	5

\*Koala food tree species are those defined in sub-indicator: Koala food tree diversity.

Table 12. Indicator description scores for non-native woody shrub cover (adapted from Eyre et al. 2015).

Description	Score
>50% of vegetation cover are non-native woody shrubs	0
≥25 – 50% of vegetation cover are non-native woody shrubs	3
≥5 – 25% of vegetation cover are non-native woody shrubs	5
<5% of vegetation cover are non-native woody shrubs	10

### *Threats from non-native predators*

To score *threats from non-native predators* you will need one camera trap per Assessment Site. If you have a large survey site (i.e. one or more Assessment Units are >100 ha), at least one replicate (i.e. 2 camera traps minimum) per Assessment Unit.

- Deploy cameras at the same season each year (i.e. once between Nov-Jan and once May-July, and avoid spring when females are denning) for 14 nights.
- Cameras must be placed at least 1 km apart (Department of Primary Industries 2018)
- Within your Assessment Site locate a strong animal track, preferably at a confluence of multiple tracks.
- Camera traps settings are high sensitivity, PIR trigger, rapid-fire and multiple photos (at least 5 per trigger).
- Set your camera on a tree or star picket facing up or down your track, preferably with the camera lens facing north or south to avoid morning or evening sunlight glare when predators are most active. Each brand of camera trap is different, but generally mounting at 50-75cm above the ground and modifying the angle by placing a block or stick behind the camera.
- Review a test photo or use the walk test function to ensure the field of view is positioned correctly.
- Set the camera.

### **Data analysis**

Ensure your data forms are labelled with the Assessment unit, Assessment site and date. Ensure they are backed-up (i.e. scanned copies or photographs of datasheets, OR save multiple copies of digital forms). Transfer your data into the template provided (Appendix H). The sheet has many automatic calculation fields and is designed for you to enter your raw data into two 'Feeder sheets':

- MASTER\_FEEDER: Enter your data from field datasheets, which will automatically 'feed' into the *Context, Extent and Connectivity* and *Habitat Quality* and *Non-native weeds* attribute sheet
- THREATS\_FEEDER: Enter your camera trap data, which will automatically 'feed' into the *Threats from non-native predators* attribute sheet.

Follow these steps to transfer your field reports to the AfN calculation sheet. A worked example is provided with the Method. The steps are as follows:

### *Context, Extent and Connectivity, Habitat Quality and Non-native weeds*

- These are all entered in to the 'MASTER\_FEEDER' Microsoft Excel template.
- This sheet is set up for a theoretical site which has up to five Sub-assets, and all three vegetation classes within them. The sheet is designed to let you fill fields that are only relevant for you.
- Fill in the 'Site Summary' section, outlining the structure of your survey. These will auto populate the other fields and guide how you enter the rest of your data.



- Transcribe your data sheets into the relevant columns below. The sheet will then calculate an average for each Assessment Unit for you.
- In the 'MASTER\_FEEDER' now enter your ordinal scores for your two landscape scale threat classes.

### *Non-native predators*

Download your photos into the file you made for your data sheets. Ensure each camera's data is saved in a separate labelled folder. Duplicate the folder for each camera trap so you have two copies of each using the following naming conventions (1) AU0X\_AS0X\_RAW and (2) AU0X\_AS0X\_CLEAN (where AU is Assessment Unit and AS is Assessment Site). In the CLEAN folder, delete all camera trap images that are false triggers (i.e. no animals). Translate the camera trap observations into a measure of activity called a relative activity index (RAI). For the purposes of this Method, the RAI is calculated as:

$$RAI = \left( \frac{E}{TN} \right) * 1000$$

where:

$E$  = number of events, where an event is 1 or more detections of the predator species (i.e. not individuals) in a single night

$TN$  = total number of trap nights.

Repeat the following for each Assessment Unit:

- Enter the data into the 'S04\_CALCULATOR\_THREATS\_' worksheet of the Excel Workbook.
- Enter the RAI estimate for each species in the relevant column.
- Enter the proportion of Assessment Sites where that species was recorded.
- Add to relevant Assessment Unit in 'S05\_MASTER\_FEEDER' worksheet of the Excel Workbook

*N.B. the number of trap nights should equal 14. Trap nights are defined as the number of nights the camera trap was actively deployed in the field. That is, the number of nights it was able to capture photos (whether it did or not). If the camera only captured photos on the 1<sup>st</sup> and 3<sup>rd</sup> nights, but was active for a full 14 days, the number of traps nights is 14. Conversely, if the camera trap batteries died after 3 nights, the number of trap nights is 3.*

*N.B. The maximum number of 'events' for each predator species is 1 per night and 14 in total.*

*N.B. Some camera trap software packages can automatically generate an RAI. Camelot Project (Mann and Henry n.d.) is a freely-available software program; however, proponents should be experienced using this software (setting event periods etc.) and understand the limitations associated with the automated calculations.*

### Output of Step 5b

- A **data table** (e.g. a spreadsheet) containing all the raw data for each **environmental indicator** for each Assessment Site.
- A folder containing all camera trap photographs appropriately labelled according to the Assessment Site.



## Step 6. B. Calculate Indicator Condition Scores

Indicator condition scores are calculated by comparing raw data a Reference Benchmark then allocating an ordinal score in accordance with criteria.

**EXAMPLE:** *The Reference Benchmark for koala food tree species richness at my site is 6 species. On my site I found 3 species. I therefore found 50% of the benchmark condition. The sheet will automatically fill an ordinal score for that indicator as 5 – 50% of the total potential points of 10.*

The primary difference between accounts of different confidence levels is that *moderate* and *high* confidence levels directly estimate the ordinal score by observation, without collecting the data that justifies that (except for the photo). *Very high confidence* accounts collect fine-scale data that creates an ordinal score. The latter has a higher level of confidence in the estimate, and lower level of potential observer bias.

This conversion into ordinal scores allows us to compare ‘like with like’ (i.e. an indicator measured out of 100 like weed cover is on par with an indicator measured out of 10). It also allows us to weight some factors to be of higher importance than others. All indicators are weighted as 10, unless they could be considered partially beyond the control of the Proponent and being influenced by broader political and social powers (connectivity, context, proximity to urban areas and road density). Table 6 and Table 7 detail scoring for *moderate* and *high* confidence Methods. Table 8 sets out indicators and maximum scoring for *very high confidence* accounts.

Table 8: Indicator scoring (very high confidence account).

Indicator	Maximum score	Reference benchmark	Weighting justification
<b>Landscape</b>			
Extent	5	100	<i>These landscape scale factors are important for koala habitat quality but cannot be impacted by management actions. The weighting of the score has been adjusted down to account for this.</i>
Connectivity	5	100	
Context	5	100	
<b>Habitat quality</b>			
Number of koala food tree species	10	Benchmark	<i>These indicators are fundamental components of high-quality koala habitat. The weighting has been increased to account for this.</i>
Number of large trees per hectare	10	Benchmark	
Koala food tree age structure	5	5	<i>These indicators are important for koala habitat but less so relative to koala food trees and large trees. Their weighting has been adjusted down to reflect this.</i>
Evidence of recruitment	5	100	
<b>Prevalence of threats</b>			
<i>Assessment site level</i>			

Indicator	Maximum score	Reference benchmark	Weighting justification
RAI of non-native predators	10	0	<i>Project proponents can directly improve habitat quality at this scale. These are weighted highly to allow the impact of these actions to show most in the score.</i>
Non-native weed cover	10	0	
<i>Landscape level</i>			
Proximity to urban areas	5	0	<i>These landscape scale factors are important for koala habitat quality, but cannot be impacted by management actions. The weighting of the score has been adjusted down to account for this.</i>
Proximity to roads – major arterial	3	0	
Proximity to roads – minor arterial	2	0	

#### *Indicator scores per Sub-asset or Assessment Unit*

The ICS for a Sub-asset or Assessment Unit can be useful for finer-scale interpretation and comparison. The individual ICS can be used to discern the specific indicators that are contributing to a low or high overall Econd™ Sub-asset.

**EXAMPLE:** *Remnant Ironbark Uplands (AU04, RE12.8.16) score lower than remnant Queensland Bluegum flats (AU01, RE12.3.3) because the Ironbark system has lower habitat quality (score 60/100 versus score 100/100, respectively).*

#### *Overall indicator scores*

This score provides an overall summary of each ICS. Individual ICS scores for each Assessment Unit and Sub-asset are combined to give a single ICS measure for the Accounting Area as a whole.

**EXAMPLE:** *This site provides excellent habitat quality (Component B) for koalas (85/100), but has poor evidence of koala activity (Component A) (20/100).*

The provided workbooks automatically transfer your raw data into the ECond™ calculator sheet. We recommend following these steps to ensure the sheet is functioning correctly.

- Cross check the Assessment Units, their relative sizes, and their attributes have been transferred correctly into the feeder sheets.
- Cross check the feeder sheets have transferred into the calculator sheet correctly. Check each Assessment Unit is there and in the right place. Check some random values throughout to ensure all the functions have worked.

Output of Step 6b

A **Data Table** (e.g. a spreadsheet) containing all the data (including calculated Indicator Condition Scores)

## Step 7. B. Calculate the Econd™

### Assessment Unit score

The Assessment Unit Condition Score is calculated as the average of the scores for all Assessment Sites within the corresponding Assessment Unit. It is calculated as:

$$\text{SUM of Assessment Unit Scores} / N$$

Where

*N = number of Assessment Sites within the Assessment Unit*

### Sub-asset score

Next, proponents are required to incorporate an area weighting to each Assessment Unit score. This ensures the area occupied by the Assessment Unit within the Sub-asset is accounted for. To weight the Assessment Unit Condition Scores by area:

- Calculate the proportion of each Sub-asset that is occupied by each Assessment Unit to give an 'area-weighting' for each Assessment Unit
- Multiply the Assessment Unit Score by the 'area-weighting' to give the 'area-weighted Assessment Unit Score', that is indexed to 100
- These scores are indexed to 100.

Next, proponents are required to incorporate an area weighting to each Sub-asset. This ensures the area occupied by the Sub-asset within the Accounting Area is accounted for. To weight the Sub-asset Condition Scores by area:

Sum the Assessment Unit Condition Scores for each Sub-asset.

- Calculate the proportion of the Accounting Area that is occupied by each Sub-asset to give a 'spatial-weighting' for each Sub-asset
- Multiply the summed value of the area-weighted Assessment Unit Condition Scores by the Sub-asset 'area-weighting' to give the spatially-weighted Sub-asset Condition Score.

Finally, proponents are required to calculate the *Econd™* for their Accounting Area. The final Koala – Habitat Quality *Econd™* is obtained by calculating the sum of the spatially-weighted Sub-asset Condition Scores.

*N.B. The provided spreadsheet will transcribe your raw data into the ECond™ calculator sheet and calculate an ECond™ from your ICS. The top of this sheet then presents ECond™ scores at a range of scales. Each of the aforementioned scores can be used to interpret and discuss the data from your Accounting Area. Some examples include:*

*The Assessment Unit score can be used to summarise the condition of a particular type of vegetation on the site, without considering the area it occupies.*

- *The remnant Queensland Bluegum flats (AU01, RE12.3.3) provides good quality koala habitat, scoring 90/100.*

*Or to compare relative quality Sub-assets or Assessment Units as habitat for the koala.*

- *Within the Accounting Area, the remnant Queensland Bluegum flats (AU01, RE12.3.3) provide higher quality habitat than the cleared Bluegum flats (AU03, RE12.3.3), scoring 90 versus 30/100 respectively. Within the Accounting Area, remnant Queensland Bluegum flats (AU01, RE12.3.3) provide higher habitat than remnant Ironbark Uplands (AU04, RE12.8.16), scoring 90 versus 50/100 respectively.*

*You can also consider the individual indicators within the Assessment Unit, for comparisons or checking why the Assessment Unit receives the score it does.*

- *The individual ICSs demonstrate that remnant Queensland Bluegum flats (AU01, RE12.3.3) provide higher quality habitat than remnant Ironbark uplands (AU04, RE12.8.16), because the Ironbark uplands have lower scores for habitat quality and koala activity and occupancy (30 and 35/100 respectively).*
- *The Sub-asset Condition Score reflects the Sub-asset as a whole and scales the contribution of each Sub-asset/ Assessment Unit (cleared, regrowth and remnant) based on how much area they occupy within the Accounting Area. You can use this score to discuss the performance of a particular Sub-asset across the Accounting Area. Across the site, the Queensland Bluegum flats contribute the least to koala recovery and conservation in their current state, scoring 10/100. Despite the excellent quality of remnant areas (Assessment Unit 03) of this Sub-asset (scoring 90/100), only 5 ha remain with the majority scoring below 10/100 as they have been cleared.*

*Or the relative quality of koala habitat between Sub-assets:*

- *Although remnant Ironbark uplands score lower than remnant Bluegum flats (score 50 versus 90, respectively), the Ironbark uplands within this Accounting Areas Sub-asset contribute the most to koala recovery and conservation in this Accounting Area in its current state, as the majority of the Sub-asset is in remnant status, with a score of 50/100.*

*The Econd™ provides a single, summarised value that can be used to describe the quality of the Accounting Area for koalas:*

- *This Accounting Area provides excellent quality habitat for koala, scoring 95/100.*

#### *Additional considerations – control over landscape level indicators*

Landscape level indicators such as proximity to roads and urban areas are generally beyond the control of the proponent. This means they are less likely to be relevant to smaller projects, however, provide useful insight when monitoring projects at scale. For example, landscape scale factors are relevant if you are trying to determine which site provides better quality habitat for koalas. Accounting for Nature® Accredited Methods are particularly useful for measuring the impact of management changes over time. If a proponent wants to assess whether management has increased koala habitat quality, it can be useful to examine only those indicators within the Econd™ that respond to management alone. For example, if you are using this account to compare changes in habitat quality within a site overtime, with a question such as ‘*has the management change I made created an increase in koala habitat quality?*’ consider interpreting your ECond™ through its components rather than the overall score. For example: ‘*After five years of management by Queensland Trust for Nature, the Econd™ for koala habitat quality increased slightly (65/100 in 2015 to 75/100 in 2020). However, when the indicators that respond to management are considered separately, the increase was greater (65/100 in 2015 to 80/100 in 2020).*’

#### Output of Step 7b

A data table (e.g. a spreadsheet) containing all the raw data for **each indicator** for each sample, including the calculations for the **ICS and Econd™**.

A summary table showing the **Econd™** scores.

### 3. Compile Environmental Account and submit for certification

Steps five to eight should be repeated at regular intervals (a minimum of every five years or where Base Year recalculation is required, as specified under the *Accounting for Nature*<sup>®</sup> Framework) to establish a trend over time. Ideally, site surveys should occur annually, even if accounts are only certified once every five years.

For your account to be certified, it must be independently audited and must comply with the *Accounting for Nature*<sup>®</sup> Standard, which outlines the criteria that must be satisfied. An environmental account may incorporate multiple Environmental Assets, and always needs to include the following information:

- Environmental Account summary;
- Information Statement;
- Environmental Account; and
- Audit Report.

## 4. References

- Australian Koala Foundation (2020). *The Koala's diet and digestion*. Australia Koala Foundation. Available at: <https://www.savethekoala.com/about-koalas/koalas-diet-digestion/> [Verified 7 April 2022]
- Bussey, J. and Ellis, W. (2016). *The koalas of Ipswich: Opportunities, threats and future viability*. Lock the Gate Alliance. Available at: [https://d3n8a8pro7vhmx.cloudfront.net/lockthegate/pages/2624/attachments/original/1456354727/3299\\_LOCK\\_THE\\_GATE\\_KOALA\\_REPORT-9V\\_SCREEN.pdf?1456354727](https://d3n8a8pro7vhmx.cloudfront.net/lockthegate/pages/2624/attachments/original/1456354727/3299_LOCK_THE_GATE_KOALA_REPORT-9V_SCREEN.pdf?1456354727) [Verified 7 April 2022]
- Butler D (2020). *Land Restoration Fund (LRF) Native Vegetation Monitoring Method*. Accounting for Nature Limited. Available at: <https://static1.squarespace.com/static/5dc38cde1d028031235ca3cf/t/6109e194e53ecf7300351da8/1628037527438/AfN-METHOD-NV-01+LRF+Native+Veg+Method+%28Accredited+April+20%29.pdf> [Verified 7 April 2022]
- Davies, N., Gramotnev, G., Seabrook, L., Bradley, A., Baxter, G., Rhodes, J., ... & McAlpine, C. (2013). Movement patterns of an arboreal marsupial at the edge of its range: a case study of the koala. *Movement Ecology*, 1(1), 1-15.
- Department of Agriculture, Water and the Environment (2022). *National Recovery Plan for the Koala: Phascolarctos cinereus (combined populations of Queensland, New South Wales and the Australian Capital Territory)*. Department of Agriculture, Water and the Environment, Canberra.
- Department of Agriculture, Water and the Environment (2020), Interim Biogeographic Regionalisation for Australia v. 7 (IBRA). Available at: <https://www.awe.gov.au/agriculture-land/land/nrs/science/ibra>
- Department of Primary Industries (NSW). (2018). *Guide for camera trapping wild dogs, foxes and feral cats*, July 2018. Available at: [https://www.dpi.nsw.gov.au/data/assets/pdf\\_file/0003/823854/guide-for-camera-trapping-wild-dogs-foxes-and-feral-cats.pdf](https://www.dpi.nsw.gov.au/data/assets/pdf_file/0003/823854/guide-for-camera-trapping-wild-dogs-foxes-and-feral-cats.pdf)
- Elmer, C (2021). *Accounting for Nature and Landcare Farming Native Vegetation Method*. Accounting for Nature Limited. Available at: <https://static1.squarespace.com/static/5dc38cde1d028031235ca3cf/t/6232d074df2d907294c67f3e/1647497340652/AfN-METHOD-NV-06+AfN+%26+Landcare+Native+Veg+Method+%28Accredited+08+February+2021%29-v2.0.pdf> [Verified 7 April 2022]
- Cristescu, R. H., Foley, E., Markula, A., Jackson, G., Jones, D., & Frere, C. (2015). Accuracy and efficiency of detection dogs: a powerful new tool for koala conservation and management. *Scientific Reports*, 5(1), 1-6.



- Eyre, T. J., Kelly, A. L., Neldner, V. J., Wilson, B. A., Ferguson, D. J., Laidlaw, M. J., & Franks, A. J. (2015). BioCondition: a condition assessment framework for terrestrial biodiversity in Queensland, assessment manual version 2.2. Queensland Herbarium, Department of Science. *Information Technology, Innovation and Arts, Brisbane*.
- Eyre, T.J., Kelly, A.L., Neldner, V.J. 2017. Method for the Establishment and Survey of Reference Sites for BioCondition. Version 3. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.
- FitzGibbon, S., Barth, B., Gillett, Aand Ellis, W. (2019). Peak Crossing koala research project 2018-2019. Final Report. Unpublished Report. Koala Ecology Group, The University of Queensland
- FitzGibbon, S., Barth, B., Gillett, Aand Ellis, W. (2017). Koala research project at Ivory's Rock Conventions and Events Property, Peak Crossing. Unpublished Report. Koala Ecology Group: The University of Queensland, Brisbane.
- Goldingay, R. L., & Dobner, B. (2013). Home range areas of koalas in an urban area of north-east New South Wales. *Australian Mammalogy*, 36(1), 74-80.
- Lunney, D., Gresser, S., O'Neill, L. E., Matthews, A., & Rhodes, J. (2007). The impact of fire and dogs on koalas at Port Stephens, New South Wales, using population viability analysis. *Pacific Conservation Biology*, 13(3), 189-201.
- Mann C, Henry, H. *Camelot Project*. Camelot. Available at: <https://camelotproject.org/>
- McAlpine, C., Brearley, G., Rhodes, J., Bradley, A., Baxter, G., Seabrook, L., ... & Timms, P. (2017). Time-delayed influence of urban landscape change on the susceptibility of koalas to chlamydiosis. *Landscape Ecology*, 32(3), 663-679.
- Mitchell D (2015). National Koala Tree Planting List. Australia Koala Foundation. Available at: [https://www.savethekoala.com/wp-content/uploads/2017/02/20150212\\_AKF\\_National\\_Koala\\_Tree\\_Planting\\_List.pdf](https://www.savethekoala.com/wp-content/uploads/2017/02/20150212_AKF_National_Koala_Tree_Planting_List.pdf)
- O'Brien, T. G. (2011). Abundance, density and relative abundance: a conceptual framework. In *Camera traps in animal ecology* (pp. 71-96). Springer, Tokyo.
- Phillips, S., & Callaghan, J. (2011). The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*. *Australian Zoologist*, 35(3), 774-780.
- Phillips, S. & Wallis K. (2016) Koala likelihood mapping – Baseline survey analysis and reporting. Final Report to NSW Environmental Protection Authority, Biolink Ecological Consultants, Uki NSW.
- Phillips, S., Wallis, K. & Land, A. (2021). Quantifying the impacts of bushfire on populations of wild koalas (*Phascolarctos cinereus*): Insights from the 2019/20 fire season. *Ecological Management and Restoration*, 22, 80-88.
- Polkinghorne, A., Hanger, J., & Timms, P. (2013). Recent advances in understanding the biology, epidemiology and control of chlamydial infections in koalas. *Veterinary microbiology*, 165(3-4), 214-223.





Rhodes, J. R., McAlpine, C. A., Lunney, D., & Possingham, H. P. (2005). A spatially explicit habitat selection model incorporating home range behavior. *Ecology*, 86(5), 1199-1205.

Rhodes, J. R., McAlpine, C. A., Zuur, A. F., Smith, G. M., & Leno, E. N. (2009). GLMM applied on the spatial distribution of koalas in a fragmented landscape. In *Mixed effects models and extensions in ecology with R* (pp. 469-492). Springer, New York, NY.

Rhodes, J. R., Beyer, H., Preece, H., & McAlpine, C. (2015). South East Queensland koala population modelling study.

Whisson, D. A., & Ashman, K. R. (2020). When an iconic native animal is overabundant: The koala in southern Australia. *Conservation Science and Practice*, 2(5), e188.

## 5. Appendix A

For *very high* and *high* confidence accounts, the following instructions are adapted from the *Reforestation by Environmental or Mallee Plantings – FullCAM* (Division 3.6, “Establishing a grid overlay”) and summarised by Butler (2020) as:

- The grid must consist of square cells.
- There must be at least 10 grid intersects within each carbon estimation area being sampled.
- An anchor point for the grid must be established by randomly selecting easting and northing coordinates within the ranges of easting and northing coordinates for the project area. Noting that a project may require more than one grid anchor point to be established.
- The easting and northing coordinates referred to in subsection (3) must be from the Map Grid of Australia, known as MGA94, or any Australian standard that replaces MGA94.
- The orientation of one axis of the grid must be either north-south (aligned to the datum being used in the project’s spatial data), or along an azimuth determined by randomly selecting a whole number angle within the range of zero and 89 degrees inclusive, where zero degrees is true north.
- Each grid intersect must be assigned a unique identifier.
- Actual plot locations must be located within 10 m of each intended plot location.

## 6. Appendix B

Table B1. Suggested spatial data sources for vegetation in each state.

State	Type	Source
Australian Capital Territory	Online spatial mapping tool	ACT Government GeoHub (2018). ACT Vegetation Map 2018. <a href="https://actmapi-actgov.opendata.arcgis.com/datasets/act-vegetation-map-2018/explore">https://actmapi-actgov.opendata.arcgis.com/datasets/act-vegetation-map-2018/explore</a>
New South Wales	Spatial layers, GIS data, technical reports, map products for NSW Vegetation types	NSW Department of Planning, Industry and Environment (2016). NSW BioNet Vegetation Map Data Collection. <a href="https://datasets.seed.nsw.gov.au/dataset/nsw-bionet-vegetation-map-catalogue-collection36515">https://datasets.seed.nsw.gov.au/dataset/nsw-bionet-vegetation-map-catalogue-collection36515</a>
	Online spatial mapping tool	NSW Government (2022). The Central Resource for Sharing and Enabling Environmental Data in NSW. <a href="https://www.seed.nsw.gov.au/">https://www.seed.nsw.gov.au/</a>
Northern Territory	Geospatial data resources	Department of Environment, Parks and Water Security (2022). Geospatial resources. <a href="https://nt.gov.au/environment/environment-data-maps/environment-data">https://nt.gov.au/environment/environment-data-maps/environment-data</a>
	Online spatial mapping tool	Department of Environment, Parks and Water Security (2022). NR Maps – Natural Resource Maps. <a href="https://nrmaps.nt.gov.au/nrmaps.html">https://nrmaps.nt.gov.au/nrmaps.html</a>
Queensland	Spatial layer	Department of Environment and Science (2021). Biodiversity Status of pre-clearing and 2019 remnant regional ecosystems – Queensland Series. <a href="https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={01972496-CD6D-4314-B0C0-DA0E0421FB0A}">https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={01972496-CD6D-4314-B0C0-DA0E0421FB0A}</a>
	Spatial layer	Department of Resources (2022). Vegetation management regulated vegetation management map. <a href="https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={9CC053EC-585B-4C41-A713-E1D04543CCC2}">https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={9CC053EC-585B-4C41-A713-E1D04543CCC2}</a>
	Online spatial mapping tool	Queensland Government (2022). Queensland Globe. <a href="https://qldglobe.information.qld.gov.au/">https://qldglobe.information.qld.gov.au/</a>
South Australia	Online spatial mapping tool	State of South Australia. NatureMaps. <a href="https://data.environment.sa.gov.au/NatureMaps">https://data.environment.sa.gov.au/NatureMaps</a>

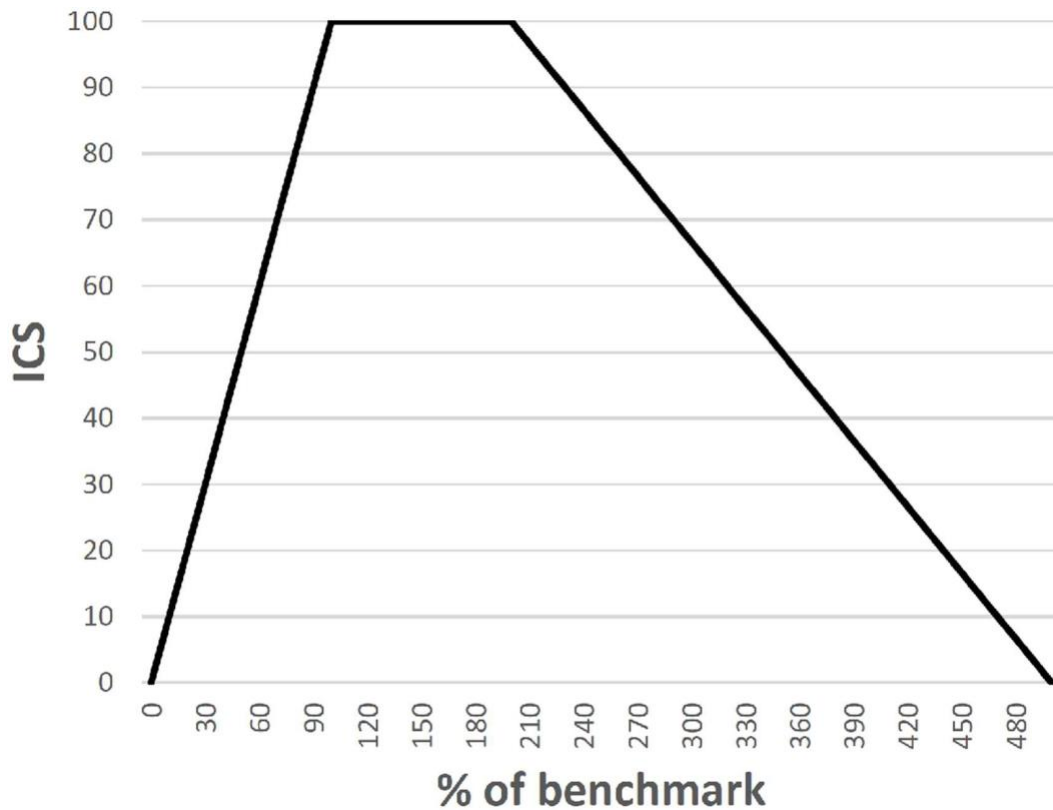
State	Type	Source
Tasmania	Online spatial mapping tool and platform with directions to download spatial datasets	Department of Primary Industries, Parks, Water and Environment. TASVEG - the Digital Vegetation Map of Tasmania. <a href="http://www.dpipwe.tas.gov.au/tasveg">www.dpipwe.tas.gov.au/tasveg</a>
Victoria	Spatial layer	Department of Environment, Land, Water and Planning (2020). Native vegetation – modelled 1750 ecological vegetation classes. <a href="https://discover.data.vic.gov.au/dataset/native-vegetation-modelled-1750-ecological-vegetation-classes">https://discover.data.vic.gov.au/dataset/native-vegetation-modelled-1750-ecological-vegetation-classes</a>
	Online spatial mapping tool	Department of Environment, Land, Water and Planning (2022). NatureKit. <a href="https://www.environment.vic.gov.au/biodiversity/naturekit">https://www.environment.vic.gov.au/biodiversity/naturekit</a>
Western Australia	Spatial layer	DataWA (2021). Pre-European Vegetation (DPIRD-006). <a href="https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006">https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006</a>
Australia-wide	Spatial layer	Commonwealth of Australia (2018). National Vegetation Information System. <a href="https://www.awe.gov.au/agriculture-land/land/native-vegetation/national-vegetation-information-system/data-products">https://www.awe.gov.au/agriculture-land/land/native-vegetation/national-vegetation-information-system/data-products</a>

Table B2. Suggested Reference Benchmark sources for each state.

State	Reference Benchmarks	Source
Australian Capital Territory	Vegetation benchmarks database	<a href="https://www.environment.act.gov.au/__data/assets/excel_doc/0004/719122/Vegetation-Benchmarks-Database.xls">https://www.environment.act.gov.au/__data/assets/excel_doc/0004/719122/Vegetation-Benchmarks-Database.xls</a>
New South Wales	BioNet Vegetation Condition	<a href="https://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/vegetation-condition-benchmarks">https://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/vegetation-condition-benchmarks</a>
Northern Territory	Not available	
Queensland	BioCondition Benchmarks	<a href="https://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks%23benchmarks">https://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks%23benchmarks</a>
	Technical descriptions	<a href="https://www.publications.qld.gov.au/dataset/re-technical-descriptions">https://www.publications.qld.gov.au/dataset/re-technical-descriptions</a>
South Australia	Native Vegetation Council (NVC)	<a href="https://www.environment.sa.gov.au/topics/native-vegetation/clearing/vegetation-assessments">https://www.environment.sa.gov.au/topics/native-vegetation/clearing/vegetation-assessments</a>
Tasmania	Bushland Assessment Manual TasVeg Vegetation Condition Assessment	<a href="https://dpiwve.tas.gov.au/conservation/development-planning-conservation-assessment/planning-tools/monitoring-and-mapping-tasmanias-vegetation-(tasveg)/vegetation-monitoring-in-tasmania">https://dpiwve.tas.gov.au/conservation/development-planning-conservation-assessment/planning-tools/monitoring-and-mapping-tasmanias-vegetation-(tasveg)/vegetation-monitoring-in-tasmania</a>
Victoria	Bioregions and EVC Benchmarks	<a href="https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks">https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks</a>
Western Australia	Not available	

## 7. Appendix C

Visual representation of formula used to translate percentage of benchmark to indicator condition score (ICS) for use in Component A – Koala Population. The function penalises both underabundance and overabundance (i.e. specifically where observed koala activity levels are more than twice the benchmark activity levels).



## 8. Appendix D

### Field equipment list for Component A – Koala Population

- A hard copy of the map (created in Step 1-3) showing your site boundary, access options, Assessment Units and Assessment Sites
- Printed data sheets (Appendix E) or any electronic data form alternatives. If using an application such as Fast Field, ensure it is installed and synced
- A handheld GPS or smart phone/tablet with your GPS locations for Assessment Sites
- DBH tape
- 10 m transect tape (*moderate* and *high* confidence only)
- 100 m measuring tape (for the transect)
- Flagging tape
- Stopwatch/ timer
- A copy of this method
- A copy of the BioCondition manual and your Reference Benchmarks for reference

### Field equipment list for Component B – Koala Habitat field survey

- A hard copy of the map (created in Step 1-3) showing your site boundary, access options, Assessment Units and Assessment Sites
- Printed data sheets (Appendix E) or any electronic data form alternatives. If using an application such as Fast Field, ensure it is installed and synced
- A handheld GPS or smart phone/tablet with your GPS locations for Assessment Sites
- DBH tape
- 10 m transect tape (*moderate* and *high* confidence only)
- 100 m transect tape
- 50 m transect tape (*very high confidence* only)
- 2 x 1.8 m star pickets per Assessment Site
- Star picket driver
- Marking paint
- Flagging tape
- Camera (smartphone is suitable)
- Weather proof labelling tags for star pickets (i.e. stock ear tags, laminated paper tags)
- Minimum of 1 camera trap per Assessment Site including batteries, SD card, pickets and straps if necessary (*very high confidence* only)

## 9. Appendix E

TableE1. Estimated koala population carrying capacity for Regional Ecosystems in Ipswich LGA (Bussey and Ellis 2016).

REGIONAL ECOSYSTEM (RE)	DESCRIPTION	AREA OF RE REPORTED IN IPSWICH LGA 2011 (HA)	ESTIMATED KOALA DENSITY (KOALAS PER HA)	POSSIBLE KOALA POPULATION SIZE	REPORTED KOALA PRESENCE IN IPSWICH LGA
12.3.3	<i>Eucalyptus tereticornis</i> woodland to open forest on alluvial plains	751	High	225	Scats
12.3.6	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus tereticornis</i> , <i>Lophostemon suaveolens</i> woodland on coastal alluvial plains	21	High	6	No reports
12.3.7	<i>Eucalyptus tereticornis</i> , <i>Callistemon viminalis</i> , <i>Casuarina cunninghamiana</i> fringing forest	279	High	84	Scats
12.3.10	<i>Eucalyptus populnea</i> woodland on alluvial plains	21	Medium	4	No reports
12.3.11	<i>Eucalyptus siderophloia</i> , <i>E. tereticornis</i> , <i>Corymbia intermedia</i> open forest on alluvial plains usually near coast	47	Medium	9	No reports
12.5.1	Open forest complex with <i>Corymbia citridora</i> on subcoastal remnant Tertiary surfaces. Usually deep red soil.	16	Low	0	No reports
12.5.2	<i>Eucalyptus tereticornis</i> , <i>Corymbia intermedia</i> on remnant Tertiary surfaces, usually near coast. Usually deep red soil.	4	High	1	No reports



REGIONAL ECOSYSTEM (RE)	DESCRIPTION	AREA OF RE REPORTED IN IPSWICH LGA 2011 (HA)	ESTIMATED KOALA DENSITY (KOALAS PER HA)	POSSIBLE KOALA POPULATION SIZE	REPORTED KOALA PRESENCE IN IPSWICH LGA
12.5.3	<i>Endangered Eucalyptus tindaliae</i> and/or <i>E. racemosa</i> open forest on remnant Tertiary surfaces	113	Medium	23	No reports
12.8.9	<i>Lophostemon confertus</i> open forest on Cainozoic igneous rocks	113	Low	1	No reports
12.8.16	<i>Eucalyptus crebra</i> , <i>E. tereticornis</i> woodland on Cainozoic igneous rocks	372	Low-Medium	74	Scats
12.8.17	<i>Eucalyptus crebra</i> , <i>E. melanophloia</i> woodland on Cainozoic igneous rocks	1526	Medium	305	No reports
12.8.20	Shrubby woodland with <i>Eucalyptus racemosa</i> or <i>E. dura</i> on Cainozoic igneous rocks	53	Medium	11	No reports
12.8.24	<i>Corymbia citriodora</i> open forest on Cainzoic igneous rocks especially trachyte	455	Low	5	Scats
12.9-10.2	<i>Corymbia citriodora</i> , <i>Eucalyptus crebra</i> open forest on sedimentary rocks	9988	Low-Medium	1998	Scats
12.9-10.3	<i>Eucalyptus moluccana</i> on sedimentary rocks	513	Low-Medium	103	Scats
12.9-10.4	<i>Eucalyptus racemosa</i> woodland on sedimentary rocks	1	Medium	0	No reports
12.9-10.5	Open forest complex often with <i>Corymbia trachyphloia</i> , <i>C. citriodora</i> , <i>Eucalyptus crebra</i> , <i>E. fibrosa</i> subsp. <i>fibrosa</i> on quartzose sandstone	154	Low	2	No reports

REGIONAL ECOSYSTEM (RE)	DESCRIPTION	AREA OF RE REPORTED IN IPSWICH LGA 2011 (HA)	ESTIMATED KOALA DENSITY (KOALAS PER HA)	POSSIBLE KOALA POPULATION SIZE	REPORTED KOALA PRESENCE IN IPSWICH LGA
12.9-10.7	<i>Eucalyptus crebra</i> woodland on sedimentary rocks	3992	Medium	798	No reports
12.9-10.8	<i>Eucalyptus melanophloia</i> , <i>E. crebra</i> woodland on sedimentary rocks	0	NA	0	No reports
12.9-10.12	<i>Eucalyptus seeana</i> , <i>Corymbia intermedia</i> , <i>Angophora leiocarpa</i> woodland on sedimentary rocks	246	Low-Medium	49	Scats
12.9-10.17	Open forest complex often with <i>Eucalyptus acmenoides</i> , <i>E. major</i> , <i>E. siderophobia</i> +/- <i>Corymbia citridora</i> on sedimentary rocks	701	Low-Medium	140	Scats
12.9-10.19	<i>Eucalyptus fibrosa</i> subsp. <i>fibrosa</i> open forest on sedimentary rocks	2645	Low /Low-Medium	132	Scats
12.11.5	Open forest complex with <i>Corymbia citridora</i> , <i>Eucalyptus siderophloia</i> , <i>E. major</i> on metamorphics +/- interbedded volcanics	6	Low	0	No reports
<b>Total</b>	-	<b>22,017</b>	-	<b>3970</b>	-

(adapted from City of Ipswich 2015b, p.101 and Woosnam 2015, p.8: Low = 0.01, Low-Medium = 0.2, Medium = 0.2, High = 0.3).

## 10. Appendix F

Table F1: A worked example of calculating a benchmark age structure for a *Eucalyptus tereticornis* dominated woodland (RE12.3.3) Assessment Unit in the Ipswich city area of southeast Queensland.

Koala food tree species	Stratum	RB height (m)	Code within this Method	Koala food tree age structure	% relative cover of species	RB stem count	Species specific stem count	Proportion of age structure	
<i>E. tereticornis</i>	LRG	na	LRG	>42cm DBH	78%	24	18	10%	
	T1	17-32	MAT	20-42cm DBH	78%	115	90	46%	
	T2	10-17	LREC	10-20cm DBH	26%	160	42	22%	
	T3	2-10m	EREC	<10cm DBH but >2m tall	49%	90	44	22%	
	N/A	<2m	REC	<2m tall	na	Present	Present	Present	
<b>TOTAL</b>								194	100%

\*\*LRG (large tree), MAT (mature recruit), LREC (large recruit), EREC (emergent recruit), REC (recruit).

For those working in Queensland, the BioCondition Stratum (T1, T2, T3 and trees above the large tree threshold from the benchmarks) is included as well as the codes ascribed to tree age groups in this method.



## 11. Appendix G

Ruleset for scale and stratification with examples



*[Insert figure]*

*Figure G1. The ruleset for determining the spatial scale of your account.*

Table G1. Examples to of how different spatial scales can be applied, including application of Component A – Koala Population and/or Component B – Koala Habitat, confidence levels (CL) and number of Assessment Sites.

	Area (hectares)	Component A: Koala Population (CL)	Component B: Koala Habitat (CL)	Number of Assessment Sites
Example 1	124 (multiple properties)	Y (Moderate)	N	7
Example 2	1120 (multiple properties)	Y (High)	Y (High)	40 (min 9)
Example 3	3800 (single property)	Y (Very high)	N (n/a)	41 (min 41)
Example 4	160 (single property)	N(n/a)	Y (Moderate)	18

**Example 1. Component A – Koala Population and Component B – Koala Habitat Account amalgamating multiple smaller properties with moderate confidence**

**CONTEXT:** A Land for Wildlife group want to document how their forest areas are supporting koalas. Six separate landholders want to construct an Accounting for Nature® Accredited – Koala Account for their properties. No single property is able to meet the 100 ha threshold alone and the landholders are not expert ecologists. They feel their management regimes are similar such that arbitrary land parcel boundaries do not impact koalas.

**SOLUTION:** The landholders amalgamate their properties into a single Accounting Area, defined by their property boundaries. They determine an account comprising Component A – Koala Population, will be sufficient for their needs, as they are only interested in whether koalas are present and their activity levels. They choose a moderate confidence level so they can collect the data themselves. They engage an external project partner to construct the Component B – Koala Habitat part of the account. The external project partner does not stratify the account and selects seven Assessment Sites across the Accounting Area.

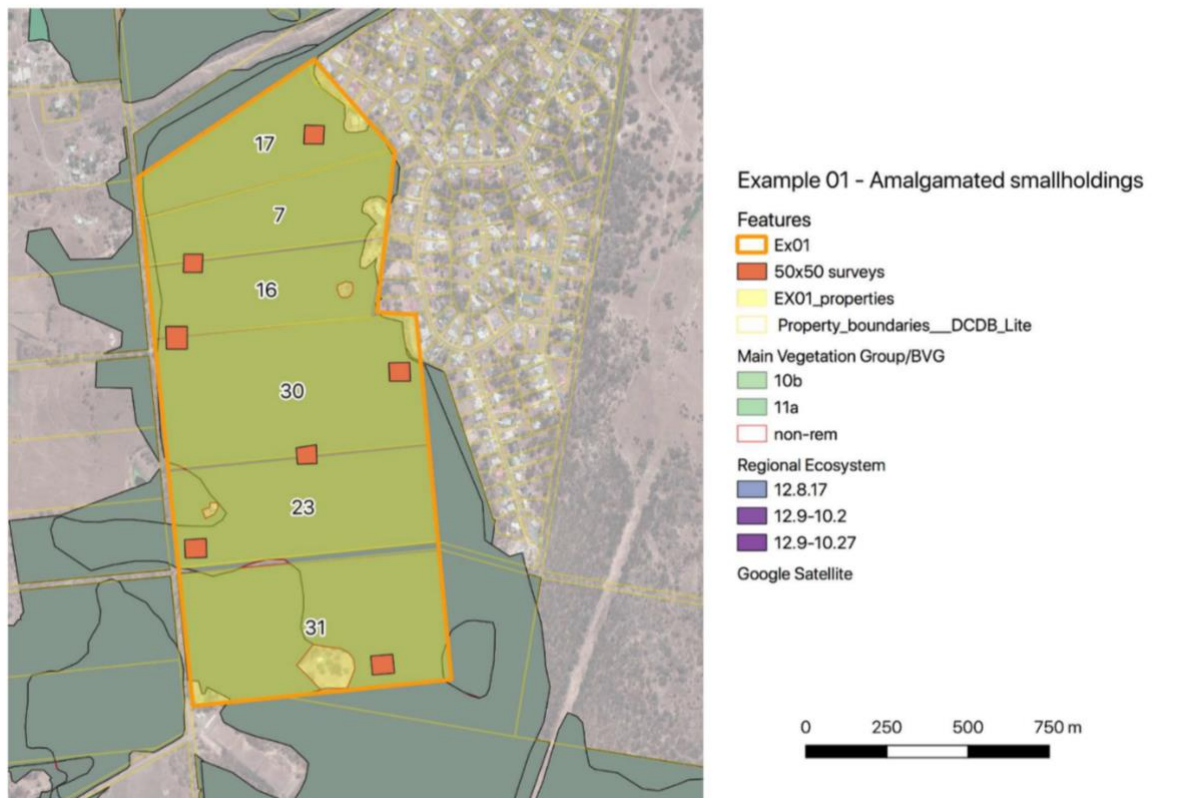


Figure G2. Stratified map and sampling design for Example 1. Each property (Property-Boundaries) is amalgamated into a single Accounting Area (EX01\_properties). As the account is of moderate confidence, vegetation is mapped as vegetated (shades of green) and unvegetated (white) with all sites being vegetated (apart from house blocks), resulting in a single Assessment Unit. Seven Assessment Sites (50x50 surveys) are allocated across the Accounting Area.

### Example 2. Component A – Koala Population and Component B – Koala Habitat Account with multiple small properties amalgamated, and *high confidence*

**CONTEXT:** A group of landholders have established a carbon abatement project and want to claim environmental co-benefits for koalas as they are a threatened species. As each landholder is managing their own project, they want the ability to discern trends in the overall project ECond™ based on the component properties. They feel confident in collecting their own Koala Population data and monitoring Koala Habitat using photo monitoring points.

**SOLUTION:** The landholders identify the Accounting Area as the combined boundary of their six properties and clip out any permanent infrastructure from this polygon. They choose to create a Koala account with both Component A – Koala Population and Component B – Koala Habitat. They select a *high confidence* level for their account. They elect to collect the data themselves but engage an external project partner to construct a single amalgamated account to match their carbon abatement forecasts and reports. They also want the ability to report the changes in koala population and their koala habitat in the restoration areas (e.g. anywhere cleared that they are replanting to koala habitat) in each property.

The external project partner follows the Method, but also ensures there are at least 3 Assessment Sites per property in their cleared areas. As the account is *high confidence*, the Assessment Sites are



stratified across vegetation clearing history only (not the vegetation type i.e. Regional Ecosystem in Queensland). Their account provides a whole project (Accounting Area) ECond™ which they can interrogate at the property scale.

Table G2. Breakdown of hectares and Assessment Units (in brackets the number recommended if the property was assessed alone, the number used as an amalgamated account) across the three different land clearing histories.

Property	Remnant	Regrowth	Cleared
1	10 (3,2)	200 (7,3)	250 (7,3)
2	15 (3,1)	10 (2,1)	75 (7,3)
3	5 (3,0)*	50 (5,3)**	20 (3,0)
4	0 (0,0)	0 (0,0)	200 (7,3)***
5	80 (5,3)	70 (5,3)**	10 (3,0)
6	55 (5,3)	30 (3,0)	20 (3,3)
7	5 (3,0)*	0 (0,0)	15 (3,3)
<b>Total</b>	<b>170 (7,9)</b>	<b>360 (7,10)</b>	<b>590 (9,21)</b>

\* Amalgamated into another Assessment Unit or neighbouring Assessment Unit.

\*\* As there is substantial of natural recovery already, the landholder is tracking koala habitat in assisted regeneration (mature regrowth) instead of environmental plantings (cleared).

\*\*\* While there is a greater extent of cleared areas on the property, the landholder is only revegetating riparian areas along a creek that in total equate to 200 ha - remaining cleared areas are excluded from the Accounting Area.

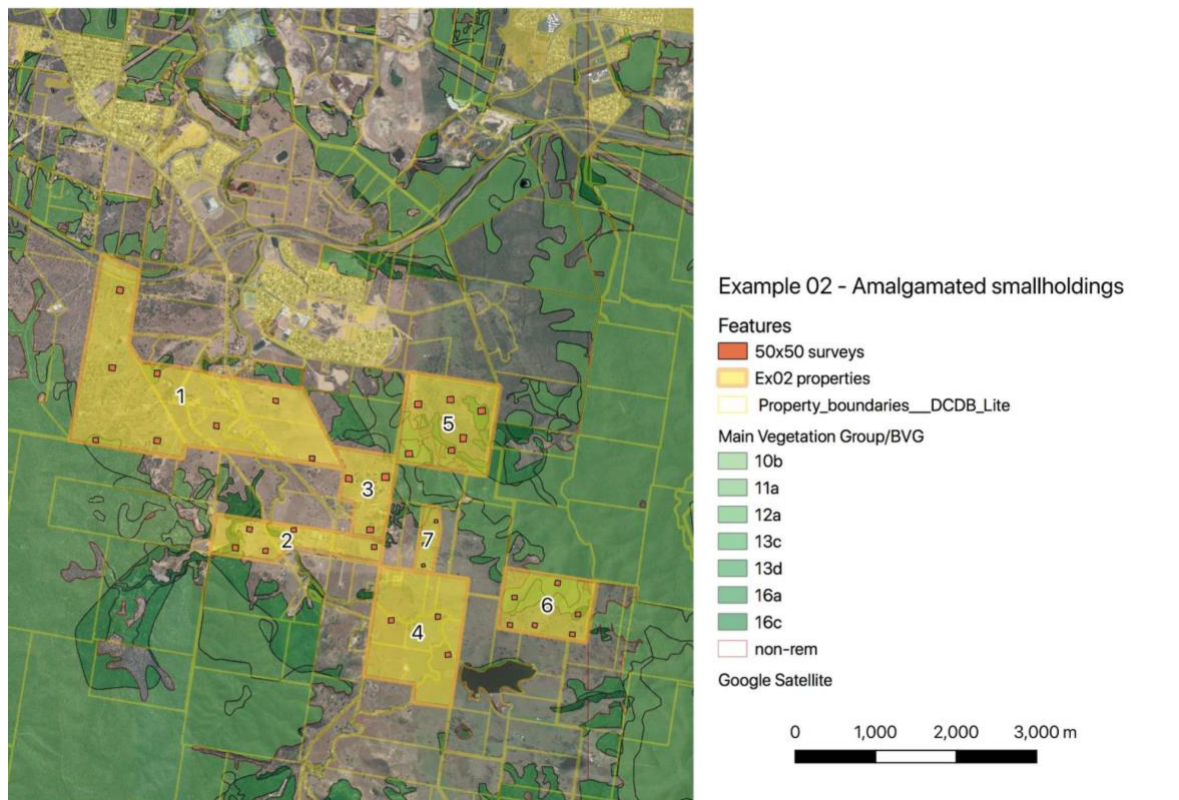


Figure G3. Stratified map and sampling design for Example 2. Each smallholding (Property\_boundaries, then numbered) is amalgamated into a single Accounting Area (Ex02 properties). The account is high confidence, so is stratified across cleared, regrowth and remnant vegetation (green vs white under Main Vegetation Groups), but enough Assessment Sites are allocated to also allow each Assessment Unit to have an average and track their own performance. Thirty 50x50m SAT surveys are allocated across the Accounting Area.



**Example 3. Component A – Koala Population Account with a single, large property and *very high confidence***

**CONTEXT:** A local government is managing a reserve as a biodiversity offset for koalas. The organisation is using the Accounting for Nature® - Koala Accredited Method to track changes in koala populations on their site in relation to management interventions. They are only interested in koala populations/activity as they are using the Queensland BioCondition framework (Eyre et al. 2015) for vegetation condition.

**SOLUTION:** The project holder sets the Accounting Area as the boundary of the biodiversity offset, which is the extent of the reserve land parcel. The number of Assessment Sites is selected according to the requirements for a *very high confidence* level account. This entails a combination of each Regional Ecosystem within the Accounting Area, and their relative clearing histories. As the Accounting Area vegetation has never been cleared this is relatively straight forward. Some Regional Ecosystems have been merged into a single Sub-asset because the vegetation types have similar food tree diversity and geology.

Table G3. Breakdown of hectares and Assessment Units (in brackets the number recommended, the number used).

Regional Ecosystem	Remnant	Regrowth	Cleared
Bluegum flats (12.3.3/12.3.11)	500 (7,7)	n/a	n/a
Spotted and Scribbly gum on sandy soils (12.5.1/12.5.3)	250 (7,7)	n/a	n/a
Scribbly gum on sedimentary rock (12.9-10.4)	940 (9,9)	n/a	n/a
Mixed woodland on sedimentary rock (12.9-10.12)	1055 (9,9)	n/a	n/a
Red ironbark on sedimentary rock (12.9-10.19)	1055 (9,9)	n/a	n/a
Total	3800 (41,41)	n/a	n/a

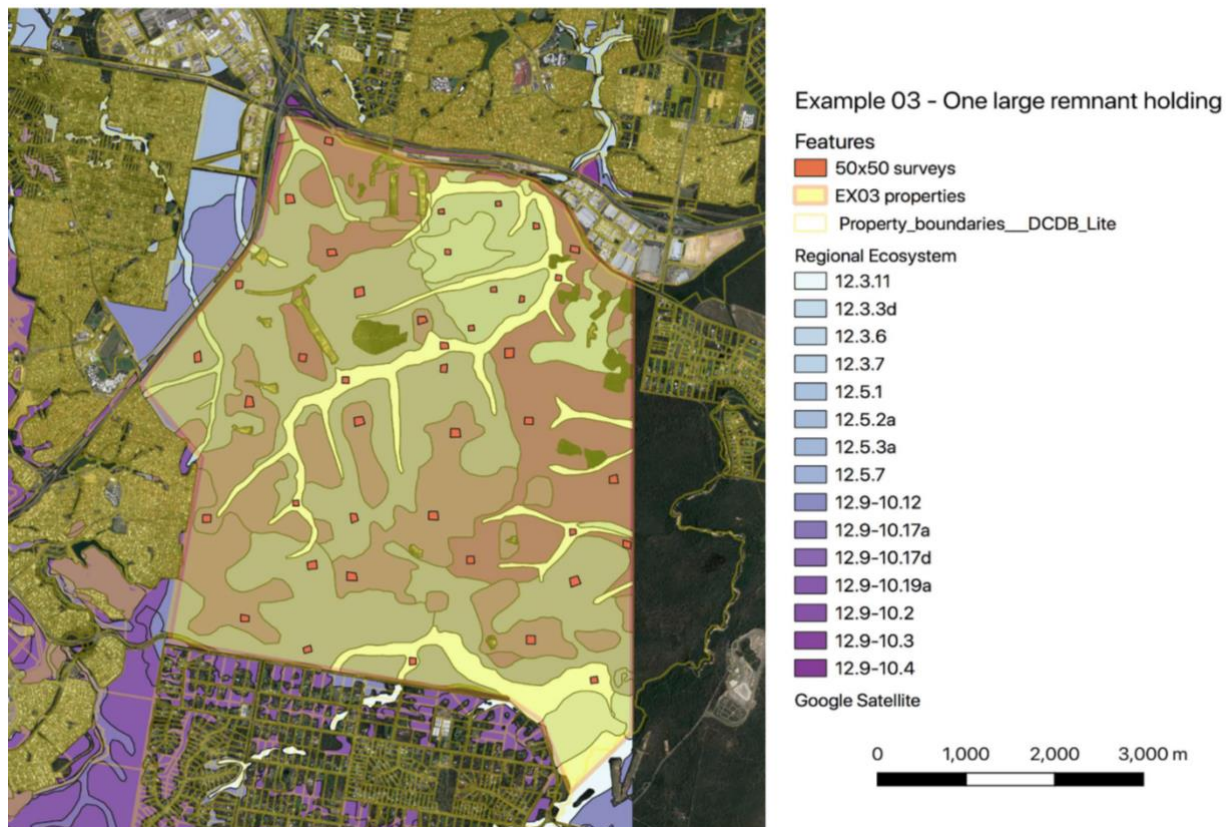


Figure G4. Stratified map and sampling design for Example 3. The single large parcel is all remnant but composed of fifteen regional ecosystems, grouped into five Assessment Units (Table 17). The account is of very high confidence, so is stratified across all Assessment Units resulting in forty-one 50x50 surveys.

#### Example 4. Component B – Koala Habitat Account on a single, smaller property with moderate confidence

**CONTEXT:** A landholder is diversifying their business from exclusive cattle production to a mixed model with environmental markets (carbon Human Induced Restoration (HIR) and environmental plantings). They aim to demonstrate that their beef is carbon neutral and improves koala habitat. Specifically, they want to demonstrate that having cattle grazing their remnant vegetation is not degrading koala habitat. They want to collect the data themselves but send it to an expert to create their account.

**SOLUTION:** The project manager identifies the property boundary as the initial Accounting Area. Subsequently, they exclude the mixed woodland Assessment Unit from the Accounting Area as it provides lower value koala habitat and they will not be undertaking management here. The project manager recommends a Component B – Koala Habitat account with moderate confidence. The project manager creates a single account for their property, ensuring there is sufficient replication across the different types of land use on the property (HIR areas, cleared grazing paddocks and environmental plantings along creek lines).

Table G4. Breakdown of hectares and Assessment Units (in brackets the number recommended, the number used). HIR (Human induced restoration); EP (Environmental Planting).

RE	Remnant	Cleared	Cleared HIR	Cleared EP
Bluegum flats (12.3.3/12.3.8/12.3.7)	35 (5,5)	25 (5,5)	35 (5,5)	10 (3,5)
Mixed woodland on sedimentary rock (12.9-10.2)	20 (0,0)	80 (0,0)	n/a	n/a
Total	55 (5,5)	105 (7,5)	35 (5,5)	10 (3,5)

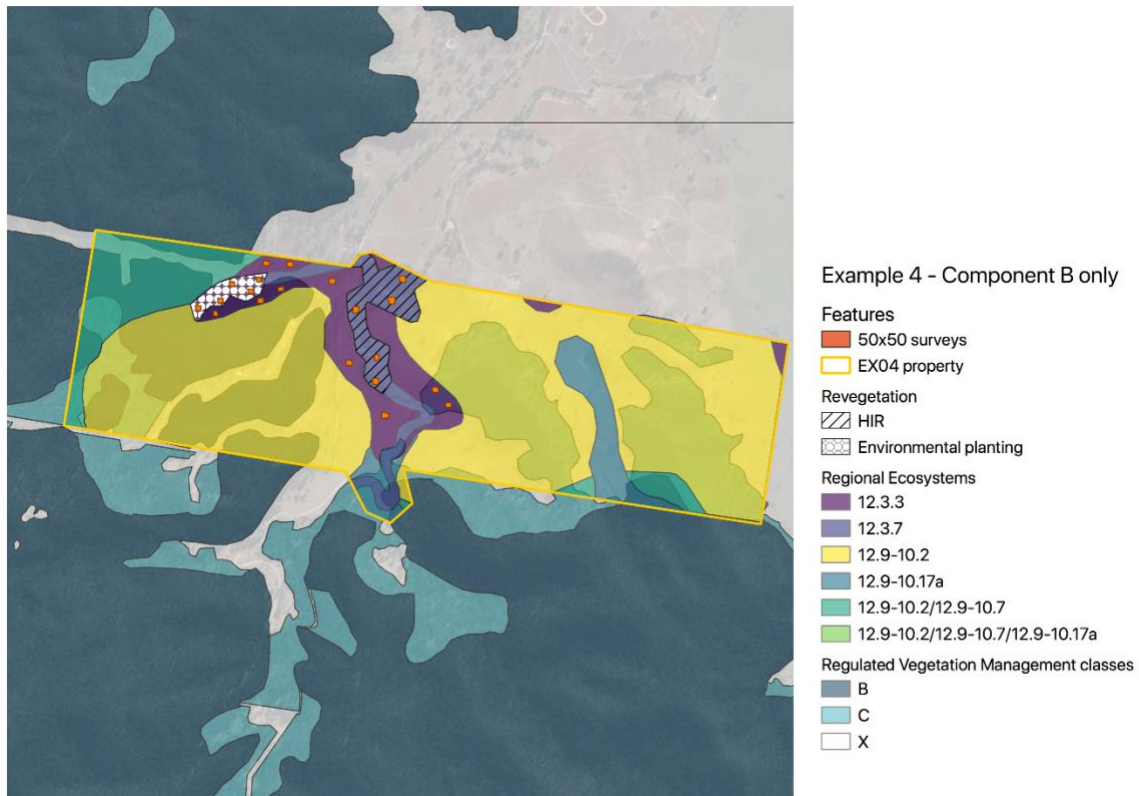


Figure G5. Stratified map and sampling design for Example 4. The single property is only interested in creating an account across landzone 3 areas (12.3.3/12.3.7), and wants to ensure the account is stratified across remnant (dark blue Regulated Vegetation Management), and cleared (white of the same) and across their two types of revegetation (HIR and environmental planting). Twenty 50x50 surveys are placed across these assessment units.

## 12. Appendix H

List of supplementary materials

Scoring templates and data sheets:

1. Koala activity levels Workbook (scoring template and data sheet)
2. Habitat Quality Workbook (*moderate confidence level*)
3. Habitat Quality Workbook (*high confidence level*)
4. Habitat Quality Workbook (*very high confidence level*)