

PREPARED FOR  
THE CITY OF  
BOROONDARA

# EAGA BIODIVERSITY MONITORING FRAMEWORK 2015

## PART II – INDICATOR IMPLEMENTATION GUIDE



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## 1. Introduction

### 1.1 Purpose of this document

The purpose of this implementation guide is to detail the monitoring methods for the four biodiversity indicators selected for the Eastern Alliance for Greenhouse Action (EAGA) region. These indicators were selected after extensive consultation with EAGA Council staff, assisted by expert advice provided by the Technical Reference Group and other consultants including Graeme Lorimer. These stages are detailed in Part 1 - Discussion Paper.

From this process, the following four indicators were selected:

- Vegetation extent
- Vegetation change
- Phenology
- Local bird communities

The following document outlines methods to capture data for each of these indicators, and recommends how data should be reported on. Each indicator can be measured independently, and although complementary, the methods and terms used for each are specific to each indicator.

### 1.2 Considerations for the use of this implementation guide

#### 1.2.1 Setting monitoring targets

No definitive targets have been set in this document, due to the differences in biodiversity assets present across the region and differing goals and resources of each Council to undertake monitoring. For each biodiversity indicator below, each Council should set a target for how much change is acceptable, and how much change would trigger a management intervention. For example, the acquisition of 5 ha of new vegetation extent may be considered an appropriate target in the Knox Local Government Area (LGA), compared to 0.5 ha in Boroondara. Similarly, the addition or loss of bird species included in this framework may also trigger further assessment and/or management intervention. These targets have not been set explicitly in this document, and should be set by each user in light of the context and resources of their organisation.

#### 1.2.2 Review of the monitoring data to assess the success of the framework

The data collected over time from this framework should be used to refine the methods and number of sites needed on an ongoing basis. For all indicators that require the collection of field data, sites should be initially established in locations representative of the local native vegetation, preferably using a stratified random sampling approach. This would entail stratifying sites based on factors likely to be different across the region, such as topography, vegetation classes and urban context, and then randomly (in an un-biased way) selecting sites within each category to adequately represent the full range of sites that occur within the region. The ultimate number of sites and quadrats to use across the region can then be reviewed using data collected, and periodically commissioning an external assessment of the data (e.g. power analysis) by a consultant to revise

how many sites need to be monitored. This will ensure that sufficient sites are monitored in the future to be able to detect statistically significant change. For example, if only small change occurs then a greater number of sites may need to be monitored to have a reasonable chance of detecting this change, if it occurs.

### **1.2.3 Cause of changes observed**

The use of any one of the four indicators in isolation will not provide direct evidence of any effect of climate change or the impact of land management decisions made by Councils in the region. We therefore recommend that all four indicators be measured within each LGA in a systematic approach. If single indicators are monitored, the resulting data must be viewed as indicative only, and may not identify the cause of any changes seen.

### **1.2.4 Training of staff in correct data collection procedures**

The reliability and quality of data is dependent upon the surveys being undertaken by people who are trained in the methods. While survey personnel do not need to be expert, they need minimum levels of training to ensure a minimum standard in the quality of the data being collected. This is especially pertinent to Indicator Two – Vegetation Change, where we recommend that only a person with excellent botanical identification skills undertakes field surveys for this indicator. It is up to each Council to decide whether they have the required expertise in-house, or if external consultants are required.

### **1.2.5 Reporting the results of the monitoring**

We recommend an external analysis of all data collected from each Council for each indicator is collated and reported on every five years, where the suggested monitoring questions listed below are addressed. We also recommend interim reports on phenology and bird communities are compiled every two-three years, as these indicators may respond more quickly than purely vegetation based indicators to extreme climate events, and/or to extreme increases or losses in habitat. These questions can be added to or tailored to each Council as required.

## 2. Indicator One - Vegetation Extent

### 2.1 Monitoring Questions

1. What is the extent of native vegetation in the region?
2. Has the extent of native vegetation changed over time and if so, where has it changed?
3. How much loss or gain has occurred?
4. How can this information be used to inform future management?

### 2.2 Definition and Background

This framework defines vegetation extent as the amount or area (ha) of native vegetation within each local government area (LGA). For the purposes of this framework this can be measured in two ways:

1. The extent of native vegetation in areas actively managed for conservation (e.g. Council managed land, bushland reserves, sites of conservation significance)
2. The extent of native vegetation across all land within the LGA (Council managed land plus private land)

Regionally, this indicator will allow Councils to track the amount and distribution of native vegetation, and hence habitat, occurring within their actively managed land, and/or across their entire LGA. The extent of vegetation within actively managed areas is unlikely to change rapidly over time, and may only increase in response to restoration and revegetation activities, or if new areas are acquired in the managed network. Vegetation extent may decline due to several factors, including land clearing, fires and other significant climate events. Hence, this indicator cannot be used to detect changes caused specifically by climate change. Instead, this indicator can indicate if the extent of vegetation is changing over time, not why it has changed. However, when combined with the knowledge and experience of the bushland management teams, the causes of any decline or increase in the extent of native vegetation can probably be determined and recorded. Given the extent of habitat loss and fragmentation in the region, the magnitude of change is likely to be small and incremental.

### 2.3 Site Selection

As some LGA's are larger than others, it is recommended that vegetation extent is mapped in order of priority, as follows:

1. The extent of native vegetation in actively managed areas on Council land (e.g. Council managed land, bushland reserves, sites of conservation significance);
2. The extent of native vegetation in sites of biological significance on private land; and/or
3. The extent of native vegetation across all other land within the LGA (i.e. Council managed land plus private land)

For the purposes of this framework, all Councils should initially map this extent following the definition agreed to by EAGA Councils as “native vegetation in actively managed areas on Council land” as a minimum requirement, using the method described in Section 2.4.

## 2.4 Data Capture

Vegetation extent may be captured in a variety of ways such as from existing soft and hard copy reports, in addition to utilising existing spatial layers. For Councils where information only exists in hard copy reports, the areas of vegetation must be manually entered into a spatial data layer using a Geographic Information System (GIS). See Section 2.4.1 for instructions of how to do this.

### 2.4.1 Creation of new GIS spatial layers

All areas of existing native vegetation within each site need to be ‘digitised’ in a GIS layer. These instructions should be carried out by Council staff such as GIS officers or consultants, as required.

The following steps should be conducted for each site. These instructions have been written for use with ArcMap version 10.x (ESRI, Redlands, California, USA), however other programs will follow a similar format. These instructions assume Councils have access to up-to-date aerial imagery for all areas they wish to map.

1. Open ArcMap, or similar GIS program
2. Load aerial imagery into the map frame
3. Locate on aerial imagery the native vegetation you wish to map. This step can be assisted by Council ground or bushland staff providing digital or hard copy maps to GIS staff depicting areas of native vegetation in actively managed Council land, using the two categories listed in point 6 below.
4. In ArcCatalog create a new shapefile (Polygon) and set coordinates to Projected>National Grid> Australia>Projected GDA1994- MGA Zone 55
5. Open attribute table and add the following fields:  
Name: VegetationType      Type: text      Length: 50
6. Within each site, classify different patches of vegetation based on the following ‘VegetationTypes’:  
Type 1 - Existing native vegetation under management; OR  
Type 2 - New, future extent (area proposed to be targeted for future bushland renewal)
7. Use the ‘create features’ tool to create a polygon layer to define the boundaries of vegetation within each site
8. Do not allow any gaps between polygons (use the ‘snapping’ functions to facilitate this)
9. For each polygon digitised, type the ‘VegetationType’ into the attribute table
10. You may also wish to add another field to the attribute table called ‘EVC’, for which each Ecological Vegetation Class (EVC) name is entered:  
Name: EVC      Type: text      Length: 50
11. Additional fields can be created that describe vegetation condition if desired, linked to on-ground measurements of vegetation condition, briefly described in Section Three below



12. Create only one polygon layer that contains the digitised polygons of vegetation for all sites you wish to map
13. Regularly save the polygon layer you are creating
14. In subsequent reporting periods, polygons created should be revised to assess if native vegetation still occurs as mapped, if new areas need to be digitised (e.g. areas of revegetation), or if areas of mapped vegetation need to be removed (e.g. due to land clearing). In the instance of bushland renewal, it may also be necessary to revise these classifications and report these changes in future reporting periods if areas classified as 'Type 2- New, future extent' can subsequently be considered 'Type 1- Existing native vegetation under management'. These decisions must be made by each Council, in consultation with bushland and ground staff, in addition to GIS staff.

#### 2.4.2 Use of existing GIS spatial layers

Much of the native vegetation within actively managed areas is already likely to be mapped within existing vegetation layers, including:

- NV2005\_EXTENT (Department of Environment and Primary Industries)
- Metro\_EVC (Australian Research Centre for Urban Ecology, developed in 2001)

The quality and resolution of NV2005\_EXTENT may be insufficient for the purposes of this monitoring framework. Instead, the Metro\_EVC layer may be more suitable for most Councils. The Metropolitan EVC data set contains polygons that represent remnant native vegetation patches, along with their EVC, in the metropolitan Melbourne region. The Metropolitan EVC data set is complete for 20 LGAs in the region, including Councils within the EAGA region (except for the Yarra Ranges). Using this layer as a base the extent of native vegetation in the area could be verified, and revised if required using the above procedure. The contact details for requesting access to this data layer is provided in Appendix A.

#### 2.5 Data Storage and Access

Each Council should create or obtain a single GIS polygon shapefile for their LGA. The shapefile should contain attributes listed above under 'VegetationType' and 'EVC' for native vegetation within either actively managed areas or across all land within the LGA. This data layer should be stored in the corporate Council GIS system. This data layer should be accessible by all relevant employees of the Council. Information needed for reporting can be extracted in a format compatible to use across the region; a suggested format for data extraction is provided in Appendix B.

#### 2.6 Synthesis and Reporting Procedure

Using the data extracted from the GIS layer, vegetation extent (ha) should be summarised across each LGA. It is recommended that vegetation extent (ha) be reported on every 5 years. Vegetation extent (ha) should be reported on for both Vegetation Type 1 and 2 across each LGA.

At each reporting period the following questions should be addressed:

- 1) Is the extent of native vegetation increasing, stable or declining?
- 2) Has the extent of native vegetation changed over time and where?
- 3) How can this information be used to inform future management?



## 3. Indicator Two - Vegetation Change

### 3.1 Monitoring Questions

1. What is the current status of natural vegetation attributes across the region?
2. To what extent have the vegetation attributes that reflect condition changed over time?
3. In which sites and vegetation types have vegetation attributes changed?
4. How are monitoring data going to be used to inform future management?

### 3.2 Definition and Background

Vegetation monitoring is the recording of vegetation attributes with the specific aim of repeating samples through time to identify and record change. Methods used should be sensitive enough to allow detection of a 'reasonable' amount of change in a 'reasonable' amount of time, with quantified uncertainty. The methods presented here are designed for the purposes of the Eastern Alliance for Greenhouse Action (EAGA) region members to monitor vegetation within their jurisdictions specifically, to allow assessment of change due to a range of influences, e.g. climate, management, or disturbances.

In setting up these quadrats each Council is indicating a commitment to continue sampling via this method (or with reviewed adjustments) into the future and store data appropriately for future access.

#### 3.2.1 Rapid assessment of vegetation condition versus monitoring change

Two common objectives of native vegetation surveys are to: 1) estimate the overall 'condition' or 'quality' of the vegetation (e.g. Habitat Hectares); and 2) monitor change through time. These are very different objectives and require different survey methods. Overall condition estimates are typically designed to be rapid and give a coarse indication of the relative quality of the vegetation attributes relative to some pre-determined benchmark. They are used to inform managers of the general state of their sites and to prioritise management. Monitoring change over time requires a much more sensitive approach because an estimate of change is of little value if it is highly uncertain. This generally requires measurements at multiple time steps rather than visual estimates.

Monitoring change of vegetation condition over time is no different to monitoring any individual variable over time; it requires detailed measurements to give a reliable estimate of change.

#### *When are rapid condition assessments useful?*

There are a range of situations where a rapid condition assessment is useful to managers: 1) if there is a mandated requirement to do condition assessments, such as for offsetting or to comply with funding agreements; 2) there may be a desire to coarsely quantify condition to help identify sites needing more or different management; or 3) managers may want an inventory of significant conservation assets (condition being one aspect of significance) to manage the spatial arrangement and area of these assets. However, rapid condition assessment information is generally too imprecise to measure change over time and is inappropriate for use in quantitative analysis. These

data are well suited though for spatial examination, i.e. mapping of sites or values for use in management prioritisation. Strategic incorporation of these types of data into the Indicator One – Vegetation Extent (see Section 2 above) may be an area for future consideration.

There are a number of different vegetation condition methods available to managers, the most common in Victoria being Habitat Hectares. This method is currently being reviewed by DEWLP and is likely to change in the coming years. Individual Councils should decide if in addition to the surveys for monitoring change described here, they also have a need to do rapid condition assessments or other visual surveys, and if so which method to use. We recommend these additional rapid assessments only be done if there is a particular need for them and an explicit understanding of how the information will be used.

### 3.2.2 Terminology

Throughout this document the following terms are used with reference to measuring vegetation condition:

- Site – the park or reserve which contains a quadrat
- Survey – the collection of data within the quadrat
- Quadrat – the 20 m x 20 m square sampling unit
- Transect – a 20 m linear sampling unit that runs across each quadrat – there are 5 per quadrat

### 3.2.3 Survey aims

The purpose of these surveys is to:

- Objectively measure the attributes of a range of vegetation variables across multiple sites in a way that will allow detection and assessment of change over time under multiple influences, i.e., climate change, management actions, natural or anthropogenic disturbance, etc.
- Characterise examples of vegetation (structure, diversity, ‘condition’) across a range of vegetation types and management regimes – but not characterise whole parks or reserves.

What these surveys do NOT do:

- This sampling method is NOT specifically a vegetation condition assessment, such as Habitat Hectares, and the values obtained are NOT intended to be combined in any way into some metric or score of overall condition. Instead, each vegetation attribute is assessed on its own merits, relevant to the requirements of the Council, which in itself is one form of ‘condition’ evaluation.

## 3.3 Site Selection and Number of Sites

The specific sites selected by each Council from the full set of parks/reserves within their jurisdiction are ultimately the decision of the Council. This decision will depend on the number of possible sites, the amount of funding available for sampling, the number of different vegetation types and conditions present within the Council area, and the expectation of future change. Sites should cover a range of vegetation types and conditions, particularly those where there is a particular interest in

monitoring change, i.e. sites where there is high current or potential future management investment, sites thought to be rapidly degrading or improving, sites vulnerable to decline from climate change or other disturbance. It is recommended that sites used under Indicator Four – Bird communities, are included as sites for monitoring vegetation change, where appropriate.

Ideally there would be two quadrats per site; this gives additional support to changes in that site but also acts as insurance in case one is damaged or disturbed. For sites with only space for one quadrat, then one will suffice. The number of sites for any one Council will depend on the level of funding and the number of bushland parks available. We recommend that 10-20 sites (20-40 quadrats) per Council be the initial target. New sites and quadrats can be added in future years if funding permits. Depending on the vegetation to be surveyed, and the experience of the surveyors, we expect that the vegetation survey of one quadrat could be completed within 40-90mins for two people (or 60-120 for one person), once the corners have been marked out in the initial setup as described in Section 3.4 below.

The location of a quadrat within a site is very important. The aim is not to fully characterise the site with this sample, but the vegetation, soil conditions, slope, and disturbances within the quadrat should be broadly indicative of the site. This will be the case for all quadrats unless there is a special circumstance where the positioning of the quadrat is to target a specific set of conditions, disturbance or vegetation (e.g. rare species). The quadrat should be located where it is less likely to receive significant unwanted disturbance or vandalism.

Management interventions within the quadrat are at the discretion of the land managers, but should be carefully considered as any change detected will be a result of both direct (e.g. management) and indirect (e.g. climate) influences. If managers desire to quantify the vegetation change directly as a result of management then management should be included within quadrats and carefully documented. We recommend that if management is to be done within quadrats then it be restricted to one quadrat per site where possible and the other quadrat untouched (e.g. no management activities to occur) to act as a comparison.

### 3.4 Survey Design and Initial Quadrat Setup

The primary sampling unit is a 20 m x 20 m square quadrat (Figure 1). All vegetation attributes are sampled within the boundaries of this quadrat. **Corners of each quadrat should be permanently marked with stakes and GPS referenced.** Depending on the location of the quadrat and amenity concerns, the stakes could be timber or metal, and could be hammered flush to the ground or protrude above ground. The primary issue is to ensure the stake remains in place between surveys to protect the integrity of the quadrat location. Efforts should be made to ensure that the dimensions are accurate and the quadrat is square. The quadrat should be positioned in a north-south orientation (Figure 1). A photo should be taken of each quadrat from the NE corner – this is not a quantitative monitoring exercise, but instead is a record to help relocate the quadrat if the permanent markers are removed and a simple visual record of each quadrat (see notes on data storage). The photo should be taken a few metres back from the corner post so that the post is visible within the photo and will act as a reference point.

Once the corners are established, the outer perimeter is delineated via a 100 m tape measure. The corners of the quadrat should intersect the tape at 0 m, 20 m, 40 m, 60 m, and a full perimeter at 80 m. Ideally, the tape would be lying along the ground (not raised on vegetation) in straight lines. If this is impossible due to dense ground cover then as close to the ground and as straight as possible will suffice. Transects across the quadrat run East-West and are located at 2, 6, 10, 14, and 18 m from the southern edge (Figure 1).

The transects are used for point sampling of under- and overstorey cover (see detailed methods in section 3.6.1 and 3.6.6), so it is important that they are straight and lie as close to the ground as possible as this can influence the sampling results.

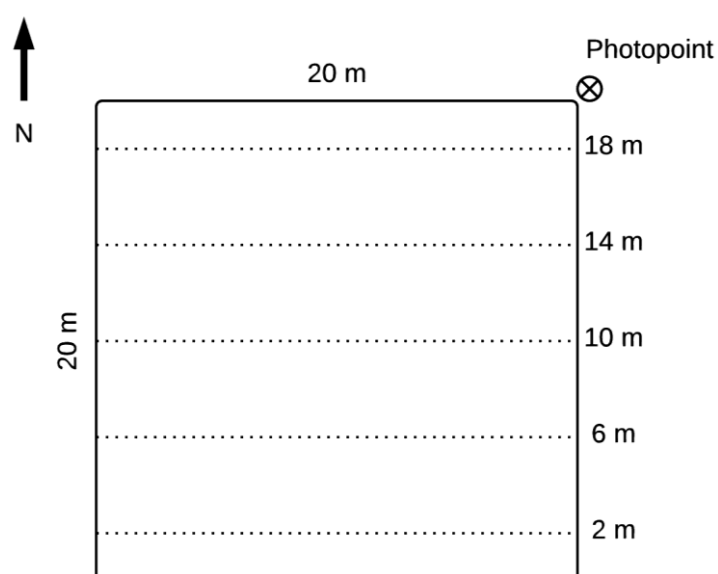


Figure 1. The quadrat sampling design to be used for all long-term monitoring sites. Permanent stakes are used to mark each corner of the quadrat. Dashed lines indicate the transects for point-sampling understorey vegetation and surface cover as well as overstorey cover. A photopoint of the quadrat should be taken from just outside the NE corner of the quadrat.

### 3.5 Data Capture

The vegetation attributes to be measured within each quadrat are shown in Table 1. Each attribute has been selected due to its importance as a biodiversity indicator, habitat value, sensitivity to climate or disturbance, or likelihood of change. For the full description of sampling methods see Section 3.6. All data recorded using these methods should be recorded using the recording sheets shown in Appendix C. We recommend a person with excellent botanical identification skills undertake the surveys for this indicator.

**Table 1. The vegetation attributes to be recorded in each quadrat.**

Attribute	Description	What this indicates	Sampling method
Understorey cover (native and exotic)	Cover of all plants less than 2 m tall and ground surface (e.g. litter, bare ground) within the quadrat	Rapid change, directly related to management, climate and disturbance sensitive.	Point sampling along line transects within quadrat
Species diversity and composition (native and exotic)	The number of different plant species in the quadrat	Rapid change, directly related to management, climate and disturbance sensitive.	Full species list in each quadrat
Recruitment of woody plants	The presence of non-planted immature individuals within the quadrat	Indicator of viable populations, vegetation condition, natural regeneration	Presence or absence of recruitment for each species listed
Mortality of woody plants	The presence of dead individuals within the quadrat	Indicator of non-viable populations, vegetation condition	Presence or absence of mortality for each species listed
Logs	The combined length of logs in the quadrat	Habitat and vegetation condition	Measure combined length of all logs in the quadrat with > 10 cm diameter
Tree density	Density of all eucalypt and non-eucalypt trees in the quadrat	Habitat and vegetation condition	Record the DBH of each individual tree in the quadrat
Tree and large shrub cover	Cover of all trees and large shrubs	Habitat and vegetation condition	Point sampling along line transects within quadrat

### 3.5.1 Survey of planted seedling survival

There are often monitoring targets that aren't directly assessed by the quadrat sampling method presented in this framework. One notable example is the monitoring of survival rates of planted seedlings as part of vegetation restoration. The effectiveness of this management action and its cost-efficiency is dependent on the survival rate of planted seedlings. The survey method recommended is to count all seedlings planted (either total or in a defined area) at the actual time of planting, and then count the number of living seedlings 1 year later. This gives a proportional amount of plant survival. One year is sufficient to assess seedling survival, but not so long that planted individuals are indistinguishable from naturally regenerating individuals. Methods such as this are an optional consideration for managers and therefore, more detailed methods for this target are not presented further in this manual.

### 3.6 Detailed Vegetation Sampling Methods

All data recorded using these methods should be recorded using the recording sheets shown in Appendix C. Surveys should be undertaken in mid to late Spring to maximise the chances of seeing all species and to observe flowering which helps with species identification. Doing the surveys at the same time of year will also ensure data are comparable between time periods. Ideally all surveys in a single year would be done within a few weeks so that there are not large seasonal differences within the set of surveys.

#### 3.6.1 Understorey and ground surface cover

Understorey and ground surface cover is probably the most important attribute for evaluating vegetation change because of the short life cycles of the plants and their subsequent potential for rapid responses to climate or disturbance. The aim is to estimate the foliage projective cover of all understorey plants (native and exotic) up to 2 m tall. Species can be recorded one of two ways: by individual species, or by life form. In the first method, the species name of every plant is recorded at each sampling point, whereas in the second option species are grouped into life form categories rather than individually; life form definitions are stated in Appendix D. Ground covers include bare ground, organic litter, bryophyte/lichen, logs and rocks and will occur at every point that is not occupied by a plant at ground level e.g. the centre of a grass tussock.

Councils choosing to do the surveys by life form should use '*Understorey point transect survey: Option 1*'; while those choosing instead to do surveys by species should use the '*Understorey point transect survey: Option 2*' (Appendix C). It is our strong recommendation that Option 1 be the default, due to the difficulty in consistently and reliably making accurate species identifications in Option 2. If Option 2 is used then it should be done by an observer with excellent botanical ID skills and able to identify species to scientific name.

Foliage projective cover (referred to as *cover* in this framework) can be measured using point sampling along line transects. At 20 cm intervals along each transect a long, narrow pole is placed vertically and each life form that touches the pole is recorded (a 'hit') as well as the ground layer (e.g. bare ground, litter, rock, etc.). The percentage cover is calculated as the number of times a particular life form is 'hit' divided by the total number of points (then multiplied by 100 to get percentage). Each life form can only score a hit once per point, regardless of the number of parts of the plant touching the pole, or the number of individual plants of the same life form touching the pole.

Pointing at 20 cm intervals (starting at 20 cm and ending on the tape at 20 m for each transect) gives 100 points per transect, i.e., 500 points per quadrat when 5 transects are surveyed. Based on this number of points, 250 'hits' of a particular life form is 50% cover, and 1 'hit' is 0.2% cover.

#### Equipment:

- 1 x 100 m measuring tape (for outer perimeter of quadrat)
- 5 x 20 m measuring tapes (for each of the five transects)
- 1 x 2 m narrow rigid pole (such as dowel, metal or plastic tube/rod, for pointing, approx. 0.5 cm diameter)





Figure 2. Understorey pointing along a transect in a grassy low-density forest. One person carries the 2 m pole and calls out ‘hits’ to the recorder who notes all observations on the recording sheets. We recommend that ‘hits’ be recorded by life-form, not by species.

### 3.6.2 Species diversity, richness, and composition

The full list of species, whether exotic or native, within each quadrat are to be recorded on the relevant recording sheet. Scientific names (e.g. *Acacia implexa*) should be given rather than common names where possible, as some species may have multiple common names. Only one **living** individual is required to record that species as being present in the quadrat. Any unidentified species should be tallied into life form groups (Appendix D) so that the diversity of each group can still be calculated. All species should be recorded either by name or in the unknown life form tally.

### 3.6.3 Species recruitment and mortality of woody species

All woody species (trees and shrubs) listed as part of Section 3.6.2 require an indication of whether they are actively recruiting or showing mortality **within the quadrat area** according to the following definitions:

- **Recruiting** is when at least one unplanted juvenile of a species occurs within the quadrat. A juvenile plant is one that is not yet reproductively mature, i.e. not large enough to produce flowers or fruits.
- **Mortality** is when at least one individual of a species is dead but still standing. A plant can be considered dead if no living leaves are present.

These observations are recorded as a tally of dead or juvenile individuals beside the species name for each woody species present in the quadrat. Woody species are all those with a woody stem. This includes all shrubs, from prostrate shrubs such as *Acrotriche serrulata* to larger *Acacias*, as well as all



trees, e.g. *Eucalyptus* spp. or *Allocasuarina* spp. All grasses and herbs that are non-woody should not be included in this section.

### 3.6.4 Log length

This is the summed length of all logs greater than 10 cm diameter within the entire quadrat area. If a log has diameter > 10 cm for part of its length and < 10 cm for another part, then the small part is excluded and only the section > 10 cm is measured. All branches of branched logs are included provided they are large enough (Figure 3). Length is recorded in metres.

#### Equipment:

- 1 x measuring tape

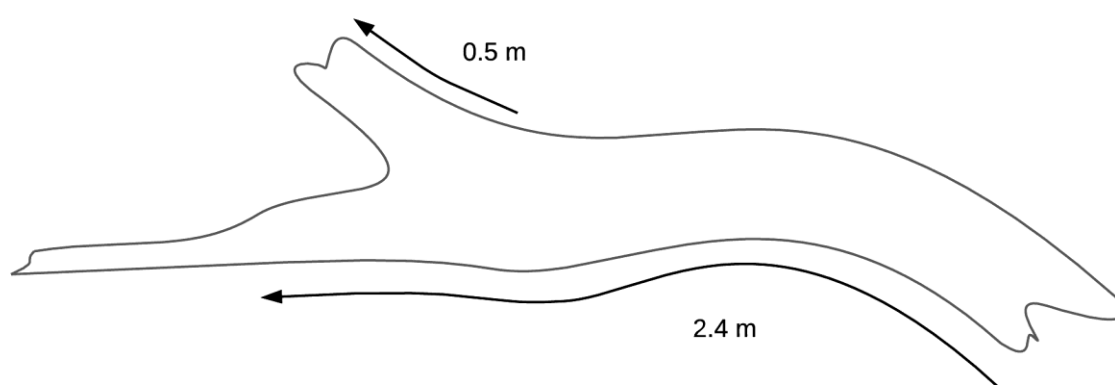


Figure 3. Measuring log length. In this example, there are two parts of the log that have a diameter wide enough for inclusion (> 10 cm) – the 2.4 m primary log, and a 0.5 m branch. The total log length for this log is 2.9 m. The narrow part at the end of the log is < 10 cm diameter so is not included.

### 3.6.5 Tree density

Tree density is a measure of the number of trees > 2 m tall of all species within the 20 x 20 m quadrat. Generally speaking a tree is any species with a growth form of a single large trunk. Occasionally multi-stemmed trees do occur and they should be included. Shrubs that branch from the base with many stems are not considered trees. The diameter at breast height (DBH – over bark) at 1.3 m from the ground is recorded for each individual tree species greater than 2 m tall, i.e. a 1.9 m eucalypt will not be included, but a 2.1 m tree will have its DBH measured at 1.3 m. Multi-stemmed trees (where the branching occurs below 1.3 m) should have all significant stems included as separate trees (NOTE: ‘significant’ stems are those that are at least one third the diameter of the largest stem). All trees are recorded if their trunk is in the ground within the quadrat. Trees occurring on the outer quadrat boundary should only be included if they occur along the northern or eastern boundaries. Trees growing on an angle should have their DBH recorded at 1.3 m from the ground wherever that point is crossed, not 1.3 m along the trunk (Figure 4).

#### Equipment:

- 1 x diameter measuring tape (or use normal tape to measure perimeter then calculate diameter – see Figure 5)

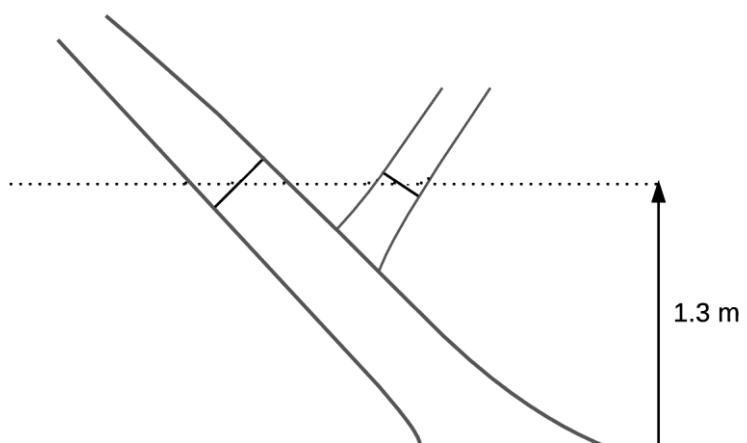


Figure 4. The location of diameter at breast height (DBH) measurement on a leaning tree with two large branches dividing below 1.3 m from the ground, so that these are measured as two separate trees.



Figure 5. Measuring the diameter at breast height (1.3 m from the ground) using: above – a diameter tape that gives the diameter directly, or below – a measuring tape that gives the circumference which can be used to calculate the diameter by dividing the circumference by  $\pi$  ( $\sim 3.142$ ).

### 3.6.6 Tree canopy and large shrub cover

This method is a modification on the point sampling of understorey vegetation along the line transects. The aim is to measure foliage projective cover of trees and large shrubs across the quadrat. At 1 m intervals along each of the five 20 m transects (Figure 1), the observer stands at that

point and records the presence or absence of foliage directly above them (Figure 6). The observer should alternate starting at 0 m and 1 m along adjacent transects to balance the spread of points across the quadrat.

The presence or absence of cover is recorded for four categories: eucalypt trees (>5 m tall), non-eucalypt trees (>5 m), juvenile eucalypt trees (2–5 m), and all non-eucalypts (2–5 m), see Figure 7. Determining which plants are within each height range can be simplified using the 2 m understorey pointing pole. All plants taller than this pole should be included in this section. If the observer stands tall and holds the end of the 2 m pole directly above them then the combined height of the observer and pole should reach to approximately 4.5–5 m. This method can also be used to do the pointing where the pole raised above the head at each point can give the observer a reference to determine if a large shrub or tree has foliage directly above that point.

Records at every metre along the five transects gives a number of ‘hits’ from a total of 100 points, i.e. the number of hits is the percentage cover. In recording foliage projective cover, this can show if there is a decline in the amount of leaf, which is related to canopy health.





Figure 6. Point sampling of canopy cover. Cover is recorded if the point directly above the observer contains leaf cover – in these examples the upper panel would score a 'hit' while the lower panel would not.

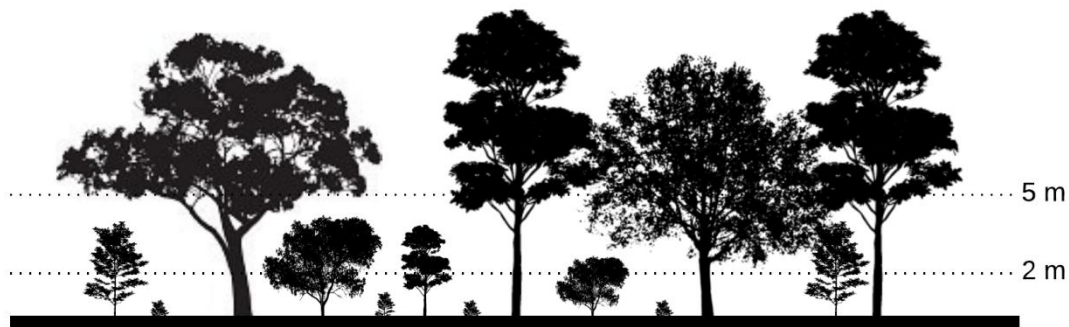


Figure 7. The height of vegetation contained within each cover zone. Large shrubs and small trees occur between 2 m and 5 m from the ground, whereas canopy cover includes all individuals above 5 m tall.

### 3.7 Data Storage and Access

Without sensible recording and storage of data, it is very easy for data to be lost or uninterpretable – particularly for long-term monitoring where the aim is to compare data over many time periods. This is a crucial step in the monitoring process and should be prioritised and checked. All data recorded (both hard copies and digital files) as part of this monitoring process should be stored for simple access in subsequent years. Consistency in labelling is key to simple and traceable data storage. Site and quadrat ID codes should be consistent across all electronic and hard copy documents and be self-explanatory. For example, for data at Blackburn Lake Sanctuary, the files may be named: ‘BlackburnLk\_quadrat1\_2015’, and ‘BlackburnLk\_quadrat2\_2015’.

#### 3.7.1 Hard copy data sheets

Hard copies of original survey sheets (provided in Appendix C) should be checked that they contain all relevant location information so that they can be linked back to their source quadrat. All data from these sheets should be transferred to digital copies, then stored together and labelled. The hard copies should be stored at least until after the next monitoring period, but ideally they would be stored indefinitely.

#### 3.7.2 Electronic data

Electronic data includes GPS coordinates, quadrat photos, and data files. All of these files should be named in a way that they can be traced back to the particular survey. A Microsoft Excel data recording example is provided as a supplementary file, and can be used as a template for data entry.

### 3.8 Synthesis and Reporting Procedure

Vegetation condition should be reported on at least every 5 years, and it is recommended that an external analysis of this data, in conjunction with data from all indicators, is commissioned every reporting period to address the suggested monitoring questions.

At each reporting period the following questions should be addressed:

- 1) Is the current status of measured attributes of native vegetation improving, stable or declining? And by how much?
- 2) Is the current status of measured attributes of vegetation within different vegetation types changing equally?
- 3) Are different vegetation types changing equally across all LGAs?
- 4) What are the likely causes of the observed changes?
- 5) How can this information be used to inform future management?



## 4. Indicator Three - Phenology

### 4.1 Monitoring Questions

1. Is the timing or duration of breeding or flowering of targeted species changing over time?
2. Where is this occurring and for what species?
3. How much change has occurred?
4. How can this information be used to inform future management?

### 4.2 Definition and Background

Phenology is the term given to the observations of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animals, involving seasonal or cyclical observations, such as the timing of fruiting or flowering, or the arrival or departure time of migratory species of animal. Plants and animals may begin flowering or breeding earlier or later in the season, or for longer if climatic conditions change.

ClimateWatch was developed by Earthwatch with the Bureau of Meteorology and The University of Melbourne to understand how changes in temperature and rainfall are affecting the seasonal behaviour of Australia's plants and animals. The first continental phenology project in the Southern Hemisphere, ClimateWatch enables every Australian to be involved in collecting and recording data that will help shape the country's scientific response to climate change. ClimateWatch has an established website (<http://www.climatewatch.org.au/>) and process for engaging citizens, including a phone app, school material and the establishment of dedicated ClimateWatch 'trails'. The information recorded is publically available via the Atlas of Living Australia. This information can be used by all Councils in the EAGA region to track changes in target species occurring locally, via the establishment of a series of 'trails', specific to the region. Incidental observations can also be captured, from across each LGA if desired.

This indicator will allow Councils to track the amount of change occurring across the region and in targeted locations for a set list of plant and animal species. The extent of phenological change is weather dependant; hence, this indicator can be used to detect changes caused by climate change. The magnitude of change will depend on the species selected for observation, which can be developed through collaboration with ClimateWatch and targeted towards species predicted to change the most. It is recommended that the same species be monitored within each Council area, to facilitate data comparison, however optional additional species can also be used where required.

### 4.3 Site Selection

Phenology should be primarily measured using established ClimateWatch trails in the region. A partnership with EarthWatch to establish a set number of trails in the EAGA region is being developed currently, subject to commitments made by each LGA.

To enable sufficient data collection under this indicator it is recommended that a minimum of three trails (but preferably more) be established in the region, each set within vegetation communities known to differ in their sensitivity to climate change.

Modelling research conducted as part of Phase 1 of this project (Meacher and Blair 2013) found that the range of some species would change markedly, particularly *Eucalyptus ovata* and *E. rubida*. The research also suggested that species within vegetation communities may respond independently to each other, resulting in changes to community composition and; different types of vegetation communities would vary in their vulnerability to climate change.

Ecological Vegetation Classes (EVCs) of greatest concern as a result of the Phase 1 modelling were:

- Grassy Woodland (City of Boroondara)
- Swampy Woodland (Cities of Knox, Monash and Whitehorse)
- Swampy Riparian Woodland (Cities of Knox, Monash and Whitehorse)
- Valley Grassy Forest (Yarra Ranges Council)

EVCs of significant concern were:

- Damp Forest (Yarra Ranges Council)
- Herb-rich Foothill Forest (Yarra Ranges Council)
- Lowland Forest (Yarra Ranges Council)
- Riparian Forest (Yarra Ranges Council)
- Shrubby Foothill Forest (Yarra Ranges Council)
- Wet Forest (Yarra Ranges Council)

EVC of concern was:

- Floodplain Riparian Woodland (City of Boroondara)

Hence, it is recommended that a ClimateWatch trail be established in native vegetation in actively managed areas (e.g. Council managed land, bushland reserves, sites of conservation significance) that contain any combination of the above listed species or vegetation communities. It is also recommended that in addition to the trails being established within Monash, Knox and Stonnington, additional trails are considered in Whitehorse and Yarra Ranges, as Phase 1 modelling suggests changes will be greatest within these LGA's. If trails cannot be established, observations can still be made on an ad-hoc basis, although trails are recommended so that the causes of change can more easily be assessed.

For the greatest uptake by the community, it is recommended that these sites are also areas of high public visitation, where an associated 'Friends of' group, or nearby School or higher education facility will allow for greater exposure to the public and could be included within curriculum. For Councils without these listed EVCs, it is recommended that places containing a mix of native and exotic plant species that are often visited by the public be considered. Once established, each ClimateWatch trail will have a map developed and instructions for data capture, including a list of species of interest. This is detailed below.

## 4.4 Data Capture

Phenology information should be captured using existing tools within the ClimateWatch program. Data should be captured primarily along established climate trails, however additional incidental observations can also be promoted by each Council and collected by any interested party. Once trails have been established in conjunction with ClimateWatch, the EAGA region will be able to access its own webpage for documenting observed changes in phenology along the trails, in addition to harvesting incidental observations for the region.

### 4.4.1 Suggested species for monitoring phenology

Once the trails are established, the EAGA region Councils can work alongside ClimateWatch to select species most relevant to monitor, although this will largely be determined by the position of the trail and the species found along it. It is recommended that most of the plant and animal species recommended by ClimateWatch be included allowing for overlap in the species monitored across the region, including a particular focus on a subset of the following bird species (Table 2), to complement the Local Bird Communities Indicator (Section 5). The species lists can be revised in the future, and are periodically updated by ClimateWatch to expand species being monitored.

**Table 2: ClimateWatch Bird Species for Victoria. These species were selected by ClimateWatch because they are conspicuous and their phenology is likely to be affected by a changing climate.**

1. Australian Magpie	17. Grey Fantail
2. Black Swan	18. Horsfield's Bronze-cuckoo
3. Black-eared Cuckoo	19. Lewin's Honeyeater
4. Black-faced Cuckoo-shrike	20. Magpie-lark
5. Channel-billed Cuckoo	21. Masked Lapwing
6. Common Blackbird	22. Pallid Cuckoo
7. Common Starling	23. Pied Butcherbird
8. Crested Pigeon	24. Rainbow Bee-eater
9. Dusky Moorhen	25. Rufous Whistler
10. Eastern Koel (formerly Common Koel)	26. Shining Bronze-cuckoo
11. Eastern Spinebill	27. Swift Parrot
12. Eastern Yellow Robin	28. Welcome Swallow
13. Fan-tailed Cuckoo	29. White-faced Heron
14. Flame Robin	30. Willie Wagtail
15. Golden Whistler	31. Yellow-faced Honeyeater
16. Grey Butcherbird	

### 4.4.2 Suggested timing of data capture

It is recommended that phenology data be collected along the established trails, or via incidental records, four times per year, or once per season (Summer, Autumn, Winter, Spring). Data capture can be facilitated by advertising the trail to local school or community groups, installing signage at each trail, and by providing information to residents about the ClimateWatch program, website and apps. This promotion should be undertaken by each Council using their existing networks and via ClimateWatch's large database of registered participants.

#### 4.4.3 Example of data captured for the Magpie-lark (*Grallina cyanoleuca*)

The ClimateWatch website describes each species listed, and why it should be monitored. For example, the website states that for the Magpie-lark, (<http://www.climatewatch.org.au/species/birds/magpie-lark>, ClimateWatch 2012) climate change is most likely to affect this species by enabling it to expand its range into the currently arid parts of Australia. The main factor limiting its distribution in drier areas is the availability of mud for nest-building, so it is often confined to watercourses or areas where water is permanently available. If climate change leads to increasing rainfall in some areas, this may enable Magpie-larks to expand into areas where it was previously unable to breed. The effects of climate change may also influence the timing of when Magpie-larks start to breed and the duration of their breeding activities. The type of data that ClimateWatch requests for each species includes the date of observation, the species, an observation about its behaviour or fruiting/flowering status, habitat type and location. In addition, a photo can be uploaded, allowing others to confirm the record, although this is not mandatory. The specific information required for a complete observation of the Magpie Lark is as follows:

##### Data recorded:

- **Abundance**
- **Date/time**
- **Sighting photo**
- **Species attributes to observe:**
  - **Behaviour**
    - Courting/mating
    - Calling
    - Feeding
    - Bird on chicks
    - Bird on eggs
    - Bird on nest
    - Bird feeding young
  - **Nest present** yes/no
  - **Habitat type** (select) from list: urban, peri urban, rural, botanic garden, nature reserve, parkland, backyard, near a natural water source, near an artificial water source, not near water, near rocky outcrop, on open plain, near a road, in medium vegetation, in dense vegetation.
  - **Location:** Latitude and longitude

#### 4.5 Data Storage and Access

The information recorded is stored and made publically available via the Atlas of Living Australia (<http://www.ala.org.au/>). The information recorded per trail and for the region can also be requested from ClimateWatch at agreed times under a data sharing agreement, for use in EAGA regional reporting.

#### **4.6 Synthesis and Reporting Procedure**

Using the data collected, phenology can be summarised across each LGA. Phenological changes per listed species should be reported on every 2-3 years.

At each reporting period the following questions should be addressed:

- 1) Is the timing and duration of flowering changing, for which species and in what direction?
- 2) Is the timing and duration of breeding changing, for which species and in what direction?
- 3) Where are these changes being observed?
- 4) What is the magnitude of these changes in comparison to the last reporting period?
- 5) How can this information be used to inform future management?

## 5. Indicator Four - Local bird communities

Birdlife Australia is a non-government conservation organisation dedicated to conserving bird species and habitat (<http://birdlife.org.au/>). Birdlife Australia and their predecessors have been conducting Australia-wide bird surveys (Atlas of Australian Birds and Birddata) since 1977 and maintain a large database of distribution and abundance data supplied mostly by citizen scientists. It is the intention of this framework to utilise existing BirdLife sites and volunteers in the EAGA region in partnership with BirdLife Australia.

### 5.1 Monitoring Questions

Bird monitoring data should be collected using the standard BirdLife two hectare 20 minute surveys to record all birds seen or heard, predominantly from already established BirdLife sites within the EAGA region. From the list of all bird species, two specific monitoring questions can be asked:

- 1) What species of climate-affected birds are occurring or disappearing in your LGA over time?
- 2) What species of urban-sensitive birds are occurring or disappearing in your LGA over time (e.g. Council managed land, bushland reserves, sites of conservation significance)?
- 3) Is the abundance or phenology of these species changing over time?
- 4) How can this information be used to inform future management?

Some species within the bird community will respond to changing climatic conditions (e.g. especially water birds), while others may respond more directly to management actions, such as revegetation or weed control activities. Field surveys should record the full inventory of birds seen or heard in each survey site, but it is recommended that the analysis of the monitoring data is directed to focus on climate affected bird species and urban sensitive bird species specifically.

### 5.2 Definition and Background

#### 5.2.1 Climate affected bird species

The species of birds found in an area can be used as an indicator of many different things such as changes in weather and climate patterns, shifting flowering, water and other food resources in an area, or local and landscape scale changes in habitat. For example, for questions relating to climate change, monitoring across a temperature or altitudinal gradient may indicate cool-climate adapted species' distributions moving to encompass cooler climate regions. Alternatively, some warm-climate species may extend or shift their distributions into the Melbourne region from areas like east Gippsland or southern NSW as Melbourne becomes warmer or as northern regions of the state become hotter and drier, especially in the north-east (Loyn and Menhorst 2011). The way this pattern could emerge is unclear, but may begin with species that were once considered rare vagrants becoming regular summer visitors and then on to overwintering or breeding in the region. For example, Eastern Koel's were once considered rare vagrants in Melbourne, but are now considered regular summer visitors (Loyn and Menhorst 2011) and eventually they may be considered residents of Greater Melbourne. This species and others are listed as likely to be affected by a changing climate in Victoria, and are listed in Table 2 above for use as indicator species in the

EAGA region. However, because all species of bird seen or heard in the surveys are recorded, the analysis of data is not restricted to these potential indicator species.

When new species are detected or become resident in Melbourne, further analysis will be required to determine what each species potentially indicates. Reliably identifying the cause of the change in species abundance or distribution will depend on knowing a number of factors including:

- Species previous distribution (e.g. southern NSW vs north QLD species)
- Possible modes of travel (e.g. did they fly on their own, escaped pets, etc?)
- What resources are they exploiting to survive in Melbourne (e.g. are they feeding on Morton Bay figs)?
- What are the likely ecological consequences of the new species (e.g. competition, predation, seed dispersal, pollination etc.)?

### 5.2.2 Urban sensitive bird species

Many bird species, especially small woodland birds, have declined dramatically in Victoria due to land cover change, land management change and disruption to the natural competitive interaction between native species and dominant hyper-aggressive species such as the Noisy and Bell Miners. The Victorian Flora and Fauna Guarantee Act 1988 lists the community of Victorian Temperate Woodland birds comprising of 24 species as threatened. These are important species that can indicate woodland and forest condition for birds. Woodland or forest was the dominant vegetation-type in the EAGA region before 1750, so for the purposes of this framework, we will focus on woodland bird species, and species known to be sensitive to habitat condition in urban areas as the second indicator group. These species are sensitive to common management actions, but sufficiently abundant and tolerant of urbanisation to occur throughout the region and be detected in managed areas. These bird species respond rapidly to increases in patch size, habitat structure, insect abundance and competition from larger aggressive disturbance tolerant species.

Patch size was recently found to be a very important factor in determining bird species richness within urban remnants (Palmer et al. 2008). Other factors that influence bird communities in the region include shrub or canopy complexity and the presence of riparian vegetation (Palmer et al. 2008). A dominant factor altering the density and richness of small bird communities is the presence of noisy miner colonies in a habitat patch (Piper and Catterall 2003). This hyper-aggressive species competitively excludes many bird species, and will influence the richness of woodland birds recorded in the EAGA region. Other factors influencing the sensitivity of birds to management actions or urban impacts are their diet, mode of foraging, and morphological traits. For example, a study by Conole and Kirkpatrick (2011) found that the species most sensitive to urbanisation are likely to be ground/shrub/canopy nesters and specialist feeders (eg. insectivores) with small or large body size.

In the Greater Melbourne area, the following species (Table 3) are currently classified as ‘remnant-reliant’ and ‘urban avoiders’, meaning they are not commonly found outside remnant vegetation and their distribution is correlated with lower urban intensity (White et al. 2005, Palmer et al. 2008, Conole and Kirkpatrick 2011). The presence of these ‘urban sensitive’ species in patches of urban bushland indicates an area contains habitat in a more ‘natural’ or ‘healthy’, and functional state.



This list is based on recently published primary literature, but the classification of individual species is likely to change over time for a range of reasons including new research, bird behavioural adaptation and climate change, and hence this table is indicative only.

**Table 3. Bird species found to be both ‘remnant-reliant’ in White et al. 2005 and ‘urban-avoiders’ in Conole & Kirkpatrick 2011. Table adapted from Conole and Kirkpatrick 2011.**

Common name	Scientific name	Foraging guild	Nest substrate	Dispersal
Australian King-Parrot	<i>Alisterus scapularis</i>	Granivore	Tree hollow	Winter/altitudinal migrant
Australian Reed-Warbler	<i>Acrocephalus australis</i>	Bush Carnivore	Emergent Macrophyte	Spring migrant
Bassian Thrush	<i>Zoothera lunulata</i>	Ground Carnivore	Shrub	Winter/altitudinal migrant
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	Foliage Searcher	Tree canopy	Sedentary
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	Raptor	Tree canopy	Sedentary
Crested Shrike-tit	<i>Falcunculus frontatus</i>	Bark Prober/Wood Searcher	Tree canopy	Sedentary
Dusky Woodswallow	<i>Artamus cyanopterus</i>	Hawker/Sweeper	Tree canopy	Spring migrant
Eastern Yellow Robin	<i>Eopsaltria australis</i>	Pouncer	Shrub	Sedentary
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	Pouncer	Brood Parasite	Spring migrant
Golden Whistler	<i>Pachycephala pectoralis</i>	Bark Prober/Wood Searcher	Shrub	Winter/altitudinal migrant
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	Bark Prober/Wood Searcher	Tree hollow	Sedentary
Little Corella	<i>Cacatua sanguinea</i>	Granivore	Tree hollow	Sedentary
Little Eagle	<i>Hieraaetus morphnoides</i>	Raptor	Tree canopy	Sedentary
Long-billed Corella	<i>Cacatua tenuirostris</i>	Granivore	Tree hollow	Sedentary
Mistletoebird	<i>Dicaeum hirundinaceum</i>	Frugivore	Tree canopy	Nomadic/irregular migrant
Nankeen Kestrel	<i>Falco cenchroides</i>	Raptor	Tree canopy	Nomadic/irregular migrant
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	Nectarivore	Shrub	Sedentary
Olive-backed Oriole	<i>Oriolus sagittatus</i>	Bark Prober/Wood Searcher	Tree canopy	Spring migrant

Common name	Scientific name	Foraging guild	Nest substrate	Dispersal
Pallid Cuckoo	<i>Cacomantis pallidus</i>	Pouncer	Brood Parasite	Spring migrant
Red-browed Finch	<i>Neochmia temporalis</i>	Granivore	Shrub	Sedentary
Rose Robin	<i>Petroica rosea</i>	Bark Prober/Wood Searcher	Tree canopy	Winter/altitudinal migrant
Rufous Fantail	<i>Rhipidura rufifrons</i>	Bush Carnivore	Tree canopy	Spring migrant
Rufous Whistler	<i>Pachycephala rufiventris</i>	Bark Prober/Wood Searcher	Tree canopy	Spring migrant
Sacred Kingfisher	<i>Todiramphus sanctus</i>	Pouncer	Tree hollow	Spring migrant
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	Hawker/Sweeper	Tree canopy	Spring migrant
Scarlet Robin	<i>Petroica boodang</i>	Pouncer	Shrub	Winter/altitudinal migrant
Shining Bronze-Cuckoo	<i>Chalcites lucidus</i>	Foliage Searcher	Brood Parasite	Spring migrant
Striated Pardalote	<i>Pardalotus striatus</i>	Foliage Searcher	Other Cavity	Sedentary
Striated Thornbill	<i>Acanthiza lineata</i>	Foliage Searcher	Tree canopy	Sedentary
Swift Parrot	<i>Lathamus discolor</i>	Nectarivore	Does not breed in study area	Winter/altitudinal migrant
Tree Martin	<i>Petrochelidon nigricans</i>	Hawker/Sweeper	Tree hollow	Winter/altitudinal migrant
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Bark Prober/Wood Searcher	Tree canopy	Sedentary
Whistling Kite	<i>Haliastur sphenurus</i>	Raptor	Tree canopy	Sedentary
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	Bark Prober/Wood Searcher	Shrub	Sedentary
White-naped Honeyeater	<i>Melithreptus lunatus</i>	Foliage Searcher	Tree canopy	Nomadic/irregular migrant
White-throated Treecreeper	<i>Cormobates leucophaeus</i>	Bark Prober/Wood Searcher	Tree hollow	Sedentary
Yellow Thornbill	<i>Acanthiza nana</i>	Foliage Searcher	Tree canopy	Sedentary
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	Foliage Searcher	Tree canopy	Nomadic/irregular migrant

### 5.3 Site Selection

We recommend that sites with a history of being surveyed by Birdlife continue to be surveyed under this framework. New sites can also be added where necessary. BirdLife runs many community monitoring projects around Australia, and relevant sites for each scheme are pooled and termed “Group Sites”, each with dedicated web pages and instructions specific to that group. The current BirdLife sites that have been adopted under this framework for the EAGA Group can be viewed at the project website: <http://www.birdlife.org.au/projects/biodiversity-monitoring-in-melbournes-east>. This web-page describes the survey methodology, sites (including a map), directions, and survey instructions, enabling any registered Birdlife volunteer to choose a site from the Group Sites list and undertake a survey. People who visit the website can download a list of recent surveys done at that site and view the data collected.

It is recommended that vegetation monitoring (Indicator Two) be undertaken at all Group Sites where bird data is being recorded. Hence, additional sites added to the current list should be suitable for both bird surveys and vegetation monitoring.

### 5.4 Data Capture

Birdlife Australia are well equipped to capture, store and maintain data on bird species distribution and abundance, as well as assisting to engage citizen scientists in capturing data. Given their well-established methodology and participant base, a partnership between the EAGA Councils and BirdLife has been developed to capture and promote the standardised collection of bird data on land managed by Councils.

#### 5.4.1 Bird surveys

Bird surveys should be conducted by using standard 20 min 2 hectare bird searches in actively managed areas (e.g. Council managed land, bushland reserves, sites of conservation significance). This data should be collected at least once per season, or four times per year (Summer, Autumn, Winter, Spring). Data collected should be recorded on standard Bird Atlas forms, given to participants once they register at the website. All data collectors should register with BirdLife, using the instructions listed below at the BirdLife methodology website.

The data collected should be used to assess 1) the occurrence or disappearance of climate affected bird species listed in Table 2; and 2) the occurrence or disappearance of urban sensitive bird species listed in Table 3.

The data collected on the standard Bird Atlas forms can be uploaded to the website, where the following is required:

- Date, time and duration of survey.
- Type of search (2 ha 20 minute search)
- No. of people undertaking the survey
- Bird species recorded, including breeding status, and abundance (number of individuals).
- For the purposes of this framework, the abundance and breeding status of each species seen is required as this information can also be used under the Phenology Indicator (Section 4).

Detailed instructions for bird surveys using the Birdlife methods can be found at <https://docs.google.com/viewer?url=http%3A%2F%2Fwww.birdlife.org.au%2Fdocuments%2FATL-Starter-Kit-2012.pdf>

#### 5.4.2 Data collection options

There are several ways bird data can be collected, including:

1. Train Council staff via training workshops run by BirdLife\* to record birds in specified locations as part of regular work programs
2. Start a Council bird survey volunteer group
3. Use friends or local field naturalist groups and the community, and train participants in bird survey methods via training workshops run by BirdLife\*
4. Engage consultants to undertake surveys
5. Develop University research links for honours or third year programs

\* BirdLife have indicated they are willing to run additional training workshops to train participants in bird survey methods, the use of the BirdLife Atlas, and data upload. They can also assign new bird watchers a mentor if requested, allowing for the ongoing training of people in bird survey techniques.

Data capture can be facilitated by advertising the program and sites to local residents, schools and community groups and by installing signage at each site. This promotion should occur via each Councils networks, and via utilising BirdLife's existing networks.

#### 5.4.3 Site monitoring

Each Council should monitor the number of surveys conducted at each site on a seasonal basis by viewing the project website. This will allow Councils to check if any sites have not been surveyed at all, allowing for targeted surveys to be commissioned via the above pathways.

### 5.5 Data Storage and Access

All data captured is entered by the observer at the website dedicated to the EAGA region <http://www.birdlife.org.au/projects/biodiversity-monitoring-in-melbournes-east>. All users must register to use the website, where detailed instructions are provided.

All data entered using this system is screened by bird experts at BirdLife and entered into the Birds of Australia Atlas. Councils can then request this data from BirdLife at agreed times under a data sharing agreement, for use in EAGA regional reporting. It is recommended that data requests include all bird species recorded per site (both current and historic records); species abundance and breeding status; survey details (date, time, survey type); and a category that flags if the listed species are either a) climate affected or b) urban sensitive to facilitate reporting under this framework.

## 5.6 Synthesis and Reporting Procedure

Bird data should be reported on in conjunction with the phenology indicator (Indicator Three, every 2-3 years), and in conjunction with using data collected under the vegetation extent and change indicators (Indicator One and Two, every 5<sup>th</sup> year).

At each reporting period the following questions should be addressed:

- 1) What was the number and abundance of climate affected species occurring or disappearing per LGA and in which locations?
- 2) What is the number and abundance of urban sensitive species occurring or disappearing per LGA and in which locations?
- 3) What is the magnitude of these changes in comparison to the last reporting period?
- 4) Has the phenology of these species changed over time?
- 5) Why are these changes occurring? Has there been a parallel improvement or decline in vegetation condition or extent?
- 6) How can this information be used to inform future management?

## 6. References

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## **Appendix A: GIS data set Metro\_EVC data layer enquiry form**

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Name: METRO\_EVC

Full name: Metropolitan Ecological Vegetation Classes (EVC)

Spatial Extent: Metropolitan Melbourne

Owner: Australian Research Centre for Urban Ecology (ARCUE)

Custodian: ARCUE

Abstract: The Metropolitan EVC data set contains polygons that represent remnant native vegetation patches, along with their EVC, in the metropolitan Melbourne region.

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The Metropolitan EVC data set is supplied free of charge for research and non-commercial purposes, on the agreement that any updates or corrections performed on the data set be provided back to ARCUE. It is also required that ARCUE is acknowledged as the owner of the data set on all published material that reproduces the data set or refers to it in any way.

ARCUE cannot warrant the accuracy or completeness of the Metropolitan EVC data set, and any person using or relying upon this information does so on the basis that ARCUE shall bear no responsibility.

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## Appendix B: Vegetation Extent data collation spreadsheet

**Council name:** Example Council *Note: This data must be generated from GIS mapping of native vegetation within each Council*

[illegible]

## **Appendix C: Vegetation Change data collection field sheets**

- 1. Understorey vegetation point transect - Option 1: recording by life form**
- 2. Understorey vegetation point transect - Option 2: recording by species**
- 3. Tree and large shrub cover, tree DBH, and log length**
- 4. Full species list in quadrat - includes native and exotic species**

### Understorey vegetation point transect - Option 1: recording by life form

Site and plot: \_\_\_\_\_

Date: \_\_\_\_\_

Observer: \_\_\_\_\_

[illegible]

### Understorey vegetation point transect - Option 2: recording by species

Site and plot: \_\_\_\_\_

Date: \_\_\_\_\_

Observer: \_\_\_\_\_

Transect number: \_\_\_\_\_

(one sheet per transect)

Species name

### Tally of hits

[illegible]

Unidentified spp.	Native	Exotic	Ground cover	
Tufted grass			Bryophyte/ lichen	
Annual grass				
Other monocot			Bare ground	
Small shrub				
Medium shrub			Litter	
Tree seedling				
Small herb			Log	
Large herb				
Climber			Rock	
Fern				

\*Note: tallies of ground covers do not need to sum to 100 for each transect, they can sum to less but not more

Tree and large shrub cover cover, tree DBH, and log length

Site and plot: \_\_\_\_\_ Date: \_\_\_\_\_

Observer: \_\_\_\_\_

Tree canopy and large shrub point transects

Tally of eucalypt trees (2-5 m tall)		Tally of eucalypt trees (>5 m tall)	
Native	Exotic	Native	Exotic

Tally of large shrubs (2-5 m tall)		Tally of non-eucalypt trees (>5 m tall)	
Native	Exotic	Native	Exotic

\* Note: The sum of all tallies can be less than or exceed 100

Tree DBH: record diameter (at 1.3 m from the ground) of every tree >2 m tall

Native	Exotic

Log length: record the length (m.cm) for each log in the plot

Notes:

**Full species list in quadrat** - includes native and exotic species

Site and plot: \_\_\_\_\_

Date: \_\_\_\_\_

Observer: \_\_\_\_\_

Scientific names should be given where possible

[illegible]

## Appendix D: Life form categories and definitions for understorey cover measurements.

Life form name	Life form code	Height	Definition
Tufted grass	TG	Any	Tufted or tussock grass, generally perennials, e.g. <i>Austrostipa</i> spp.
Annual grass	AG	Any	Non tufted annual grass, e.g. <i>Briza</i> spp.
Other monocot	OM	Any	All other non-grass monocots, e.g. <i>Dianella</i> spp., <i>Arthropodium</i> spp., <i>Lomandra</i> spp.
Small shrub	SS	< 50 cm	Prostrate, small and juvenile shrubs
Medium shrub	MS	50 cm to 2 m	Medium shrubs
Tree seedling	T	< 2 m	Eucalypt and non-eucalypt tree seedlings
Small herb	SH	< 20 cm	Small and juvenile herbs (non-woody)
Large herb	LH	> 20 cm	Large herbs (non-woody)
Climber	C	Any	Scrambling or climbing species that may occur on the ground or on other plants, e.g. <i>Hardenbergia</i> spp.
Fern	F	< 2 m	Fern of any form
Bryophyte/Lichen	BL	NA	Bryophytes, soil crust and lichens
Bare ground	BG	NA	Bare soil surface
Litter	L	NA	All organic litter and logs < 10 cm diameter
Log	Log	NA	Logs > 10 cm diameter
Rock	R	NA	Either loose rocks or large surface rocks

**Note:** The same categories apply to both native and exotic species.