

Biodiversity Monitoring in Melbourne's East

Bird Component

Technical report prepared for
The Eastern Alliance for Greenhouse Action

Dr Kerry Herman
BirdLife Australia
March 2016

Biodiversity Monitoring in Melbourne's East: Bird Component

Technical Report prepared by Kerry Herman, BirdLife Australia, for the Eastern Alliance for Greenhouse Action (EAGA).



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Executive Summary

The Eastern Alliance for Greenhouse Action (EAGA) is a consortium of seven local government areas (LGAs) in the middle to outer-eastern suburbs of Melbourne. Participating LGAs are Boroondara, Knox, Maroondah, Monash, Stonnington, Whitehorse and Yarra Ranges. The EAGA was formed in 2008 in response to community concerns about climate change and a desire to drive environmental sustainability initiatives in a coordinated manner in the eastern region of Greater Melbourne.

Thirty-five priority areas were established through a consultation process with the EAGA councils, and long term bird survey sites establish. These sites will be used to follow the changes in urban and climate sensitive bird species. These sites incorporate vegetation condition plots which will be monitored along with the birds.

Since the project launch mid 2015, 122 bird surveys have been undertaken across 28 of 35 sites. This data has enabled baseline measures to be established at a number of spatial scales – across the EAGA region as a whole, across each of the Local Government Areas (LGA) and across individual sites. These baselines are for data across the study sites only and care should be taken in extrapolating the results across the landscape in general, however the intention behind this project is for longterm modelling and returning to these same sites consistently will allow this aim to be met.

After the first six months of this project, 97 bird species were recorded across the survey sites. This is 63% all species (153) recorded at these sites since 1998 (Australian Bird Atlas). A total of 6786 individual birds have been counted.

Diversity Indices were calculated for each site and the LGAs. This is a measure of both species richness, as well as the proportion of individuals species within the overall abundance of birds counted. Values varied from 2.78 to 3.26 across the LGAs, reflecting the differences in the species richness and species abundances across the survey sites. Sites themselves ranged from 1.13 to 3.25, with the less diverse sites being small isolated areas, or heavily modified sites, and more diverse sites reflecting heterogeneity in available habitat such as wetland areas or structured understorey. These diversity scores provide a baseline from which to measure change over time. They should not be used to directly compare sites as habitat, size of site; context and other variables differ between sites. It is unrealistic to expect a small, isolated woodland park to have the same diversity index as a large, wetland area that occurs within a green corridor.

The configuration of the bird communities was modelled for each LGA. This allows us to explore how widespread and abundant individual bird species are. Sites with lower diversity index scores were found to have a lot of species that were limited in their distribution across sites and a few species that were both widespread and abundant. The LGA with the highest diversity score (Stonnington) shows an avian assemblage where there is a continuum from low abundance, limited distribution bird species, to mid-range species to widespread and abundant species. Other LGAs that showed similar configurations were missing these mid-range species; individual bird species were either found at few sites in low numbers or at all sites in high numbers. The other configuration found showed a much more even abundance and distribution of bird species, occurring in the three eastern most LGAs.

Bird species identified as climate change species were explored. Four of the 31 species identified show significant changes in their frequency of occurrence since 1998, however it is difficult to determine what is driving these changes. Willie Wagtails, one of the four species has shown a major decline. This is thought to be driven by increases in the Pied Currawongs in the urban environment, but further testing is required. There is some indication that Black-faced Cuckoo-shrikes may be overwintering in Melbourne, which may indicate a shift in behaviour in response to climatic changes.

Urban sensitive species are still detectable across sites within these urban environments; however the effort required to find them is increasing, except in the Yarra Ranges where 20 of the identified 38 urban sensitive species were recorded across ten surveys. There were no discernible longterm trends in the data recorded for any of the urban species.

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Introduction

The Eastern Alliance for Greenhouse Action (EAGA) is a consortium of seven local government areas (LGAs) in the middle to outer-eastern suburbs of Melbourne (Figure 1). Participating LGAs are Boroondara, Knox, Maroondah, Monash, Stonnington, Whitehorse and Yarra Ranges. The EAGA was formed in 2008 in response to community concerns about climate change and a desire to drive environmental sustainability initiatives in a coordinated manner in the eastern region of Greater Melbourne.

The current project “Biodiversity Monitoring in Melbourne’s East” was a recommended action from an earlier project (see Meacher and Blair 2013), and involved the development and trial of a framework to monitor biodiversity and habitat health in a changing climate and facilitate the development of adaptive management techniques (Threlfall *et al.* 2015). The Australian Research Centre for Urban Ecology (ARCUE) and the University of Melbourne were engaged to work with EAGA councils to research and develop a monitoring framework comprising a discussion paper and an implementation guide.

The implementation guide included local bird communities as one of four indicators of biodiversity health. Birds make good indicators as they are relatively easy to detect and identify, can be censused efficiently and over varying spatial scales, and we generally have a better understanding of how occurrence, abundance and reproductive success is influenced by environmental variable (Carrigan and Villard 2002) than for other faunal groups.



Unlike Australian mammals most bird species are active during the day (diurnal), and in urban environments many of the species encountered are large bodied, gregarious or vocal. These characteristics, and the general community engagement with birds, make them ideal for community-based monitoring projects. Additionally, there is an increasing body of research that show that many bird species are effected by, and responding to, climatic changes, and that these changes are readily detectable (see Franklin and Garnett 2014 for a comprehensive analysis on climate change and Australian birds). Key changes include changes to distribution (both latitudinal and altitudinal), changes in movement patterns, changes in abundance and community composition, changes to phenology and changes to physiology, morphology and behaviour (Chambers *et al.* 2005). The other three biodiversity

BirdLife Australia (BLA) was brought into this project by the partners (EAGA, ARCUE and Uni Melb) to assist in the collection and management of bird survey data. BLA has a long history of developing and implementing citizen science bird monitoring projects and it is necessary to engage with the community to collect the data required for this project. The organisation also has a wide supporter base and branches of volunteers that have been approached to assist with the data collection.

The aim of this initial report is to assess how the project has been running after approximately 6 months as well as provide some base line analysis of bird species communities across the EAGA landscape. Data has been compiled from the specific EAGA surveys, from the BirdLife Australia Atlas of Australian Birds and e-bird¹. Combining these data sources increases the data available for analysis; however there are still data limitations, particularly at the site level. Subsequently much of the more in depth analysis has been undertaken at the landscape or LGA scale. Climate sensitive bird species and urban sensitive bird species have been explored, again generally across the EAGA region as a whole.



Rainbow Lorikeet

¹ e-bird is an electronic online checklist program, launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society, U.S.A. Data is not necessarily in the same standardised format as required by the BirdLife Australia Atlas project, however some surveys undertaken do conform to the survey requirements and have been incorporated into the atlas.

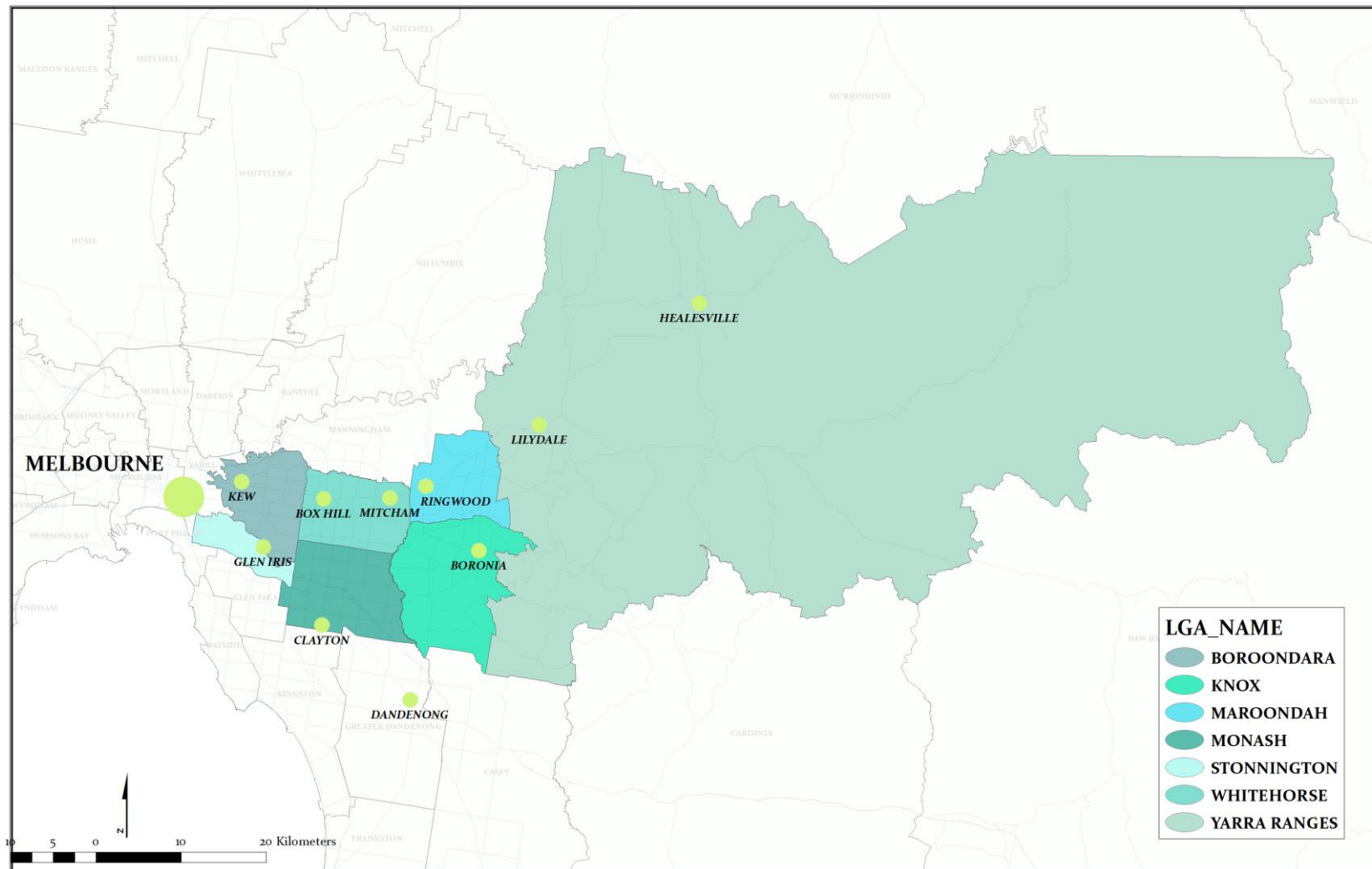


Figure 1 Eastern Alliance for Greenhouse Action (EAGA) region.

Methods

Site Selection

Across the seven EAGA LGAs 35 survey sites were defined in consultation with each council. These sites were selected for their significance within the council areas, with consideration given to the availability of historic bird data. Bird survey areas were specifically located within each of the sites to include the vegetation condition plots established as a part of the “Biodiversity Monitoring in Melbourne’s East” project. Figures 2 - 8 shows the location of each of the sites within their appropriate LGA. Further details for each site can be found in Appendix 1.

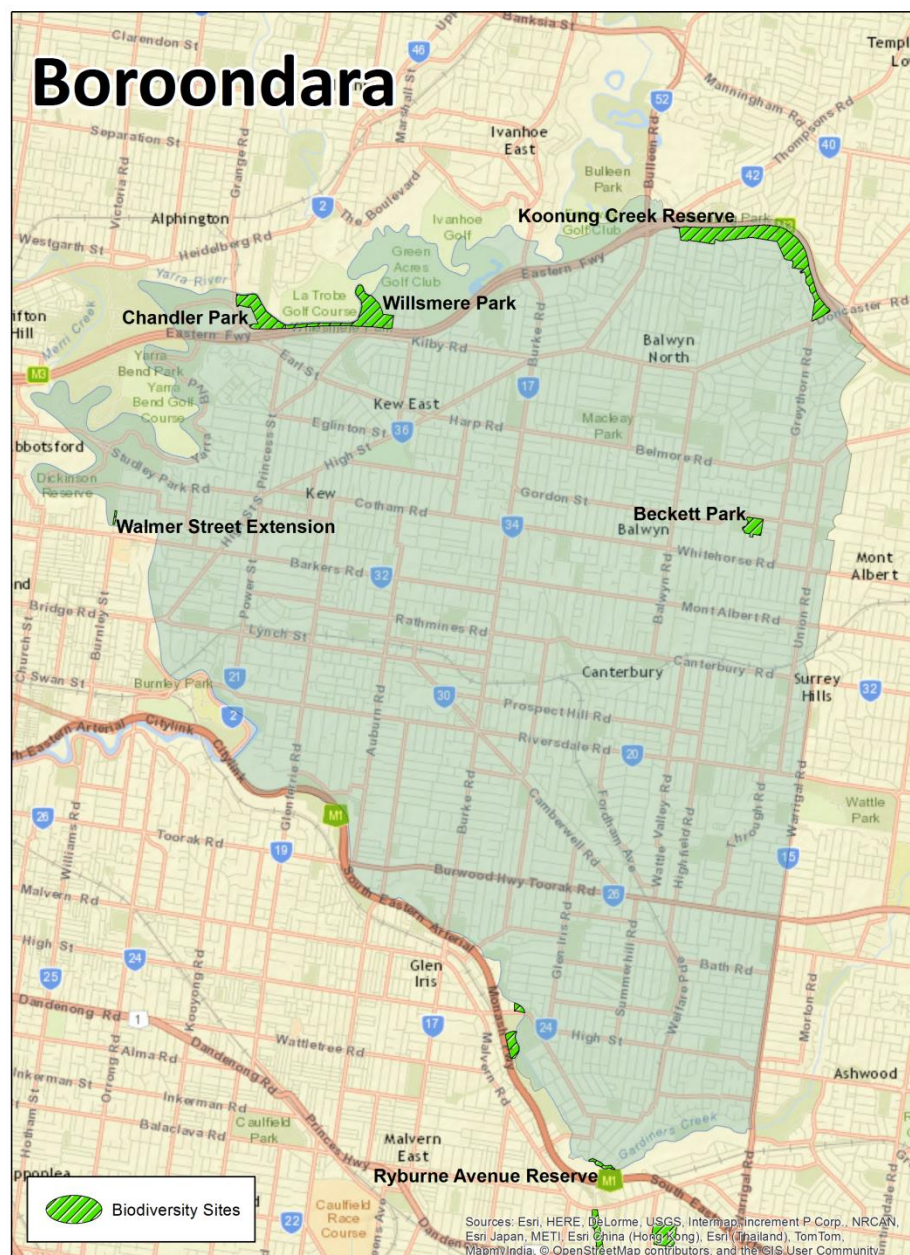


Figure 2. Survey sites in Boroondara municipality

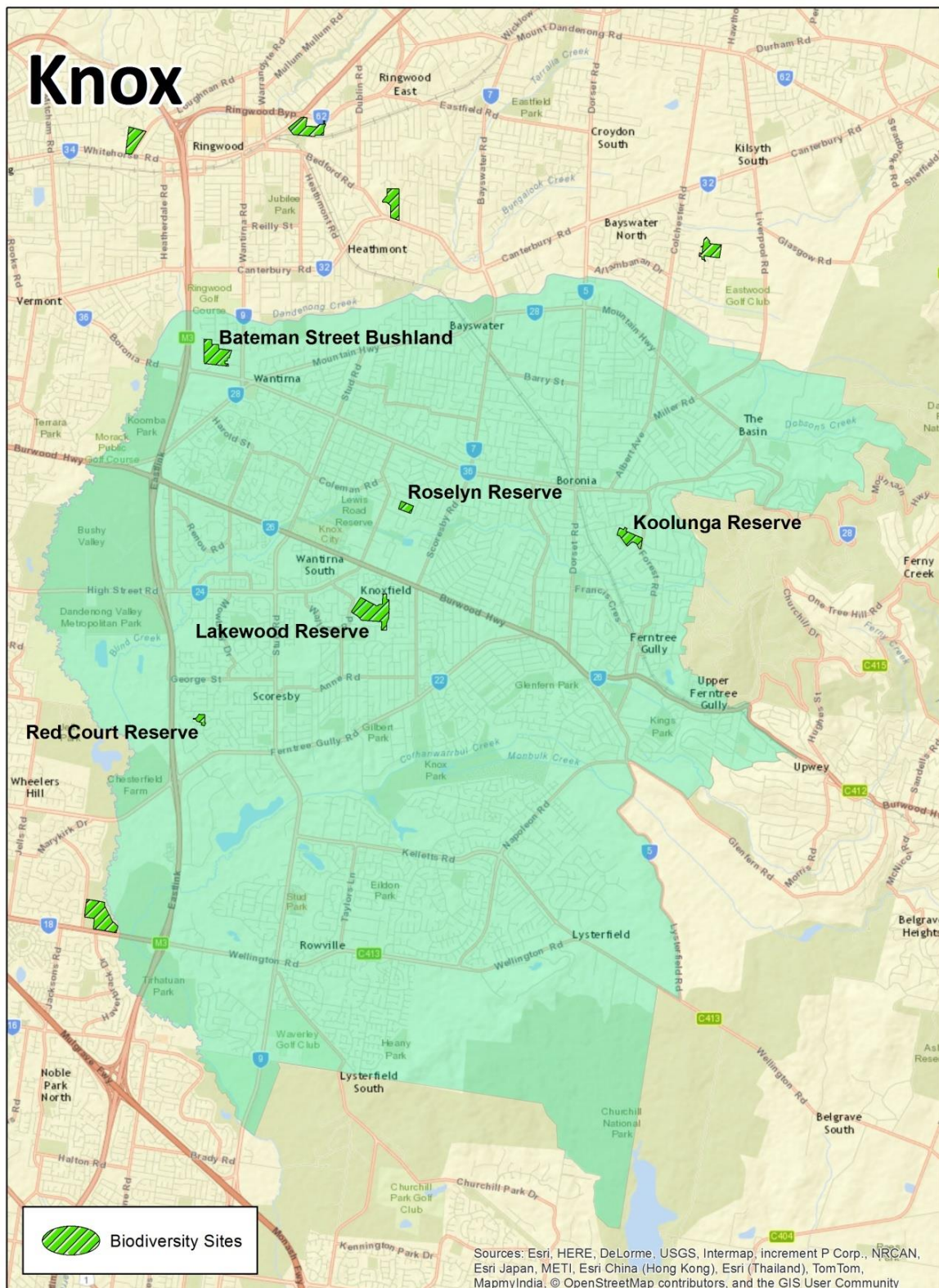


Figure 3. Survey sites in Knox municipality.

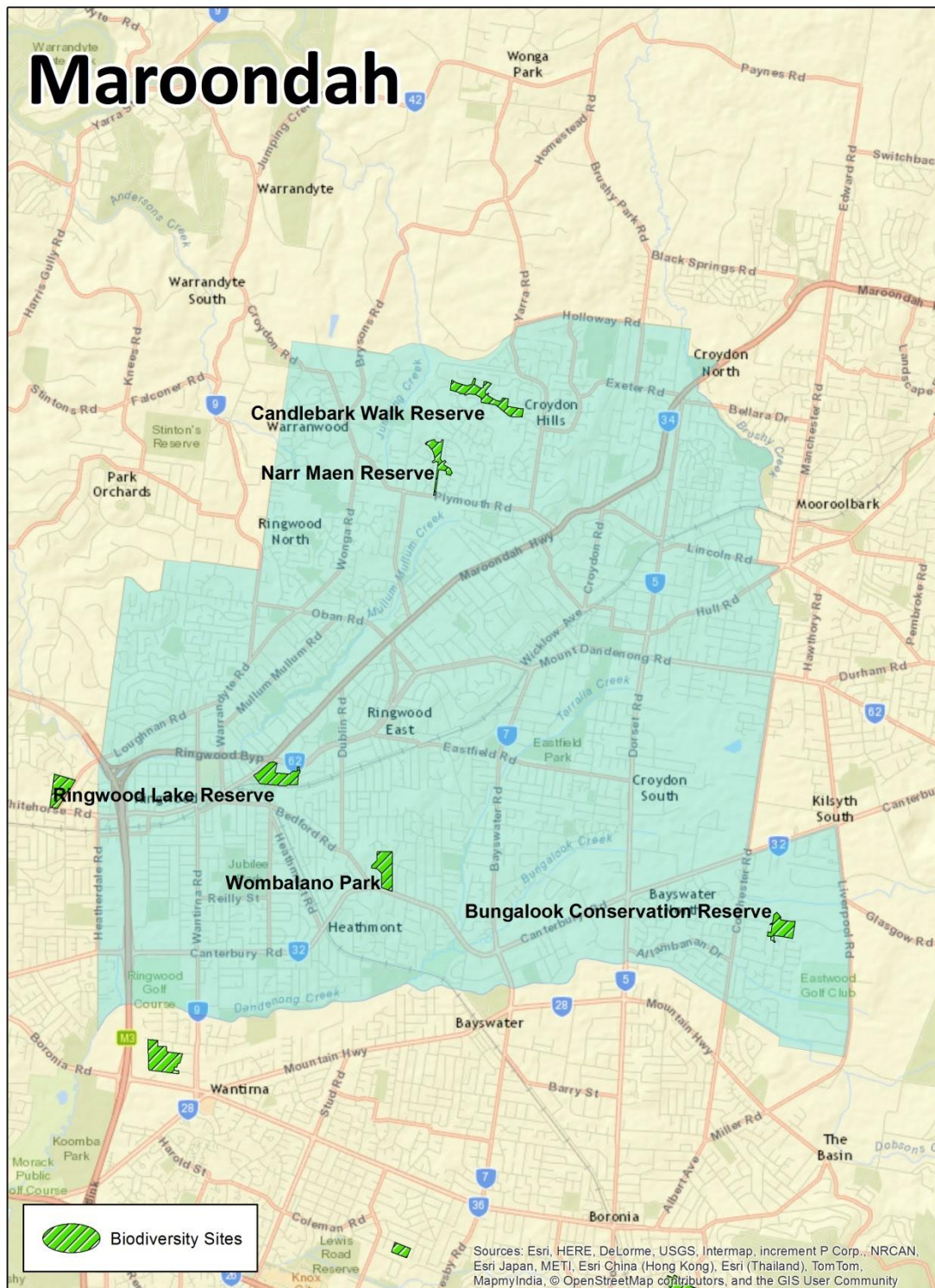


Figure 4. Survey sites in Maroondah municipality.

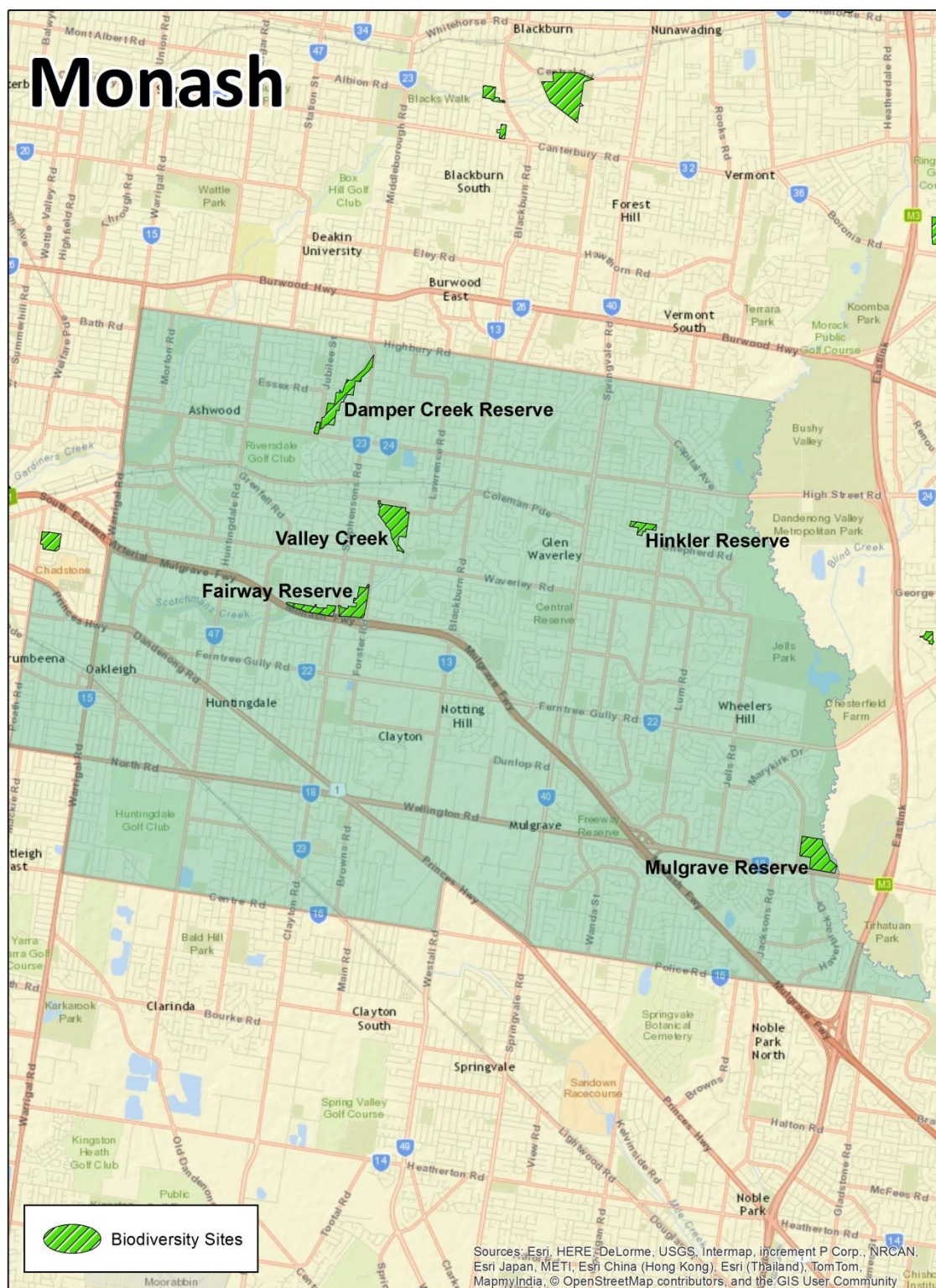


Figure 5. Survey sites in Monash municipality.

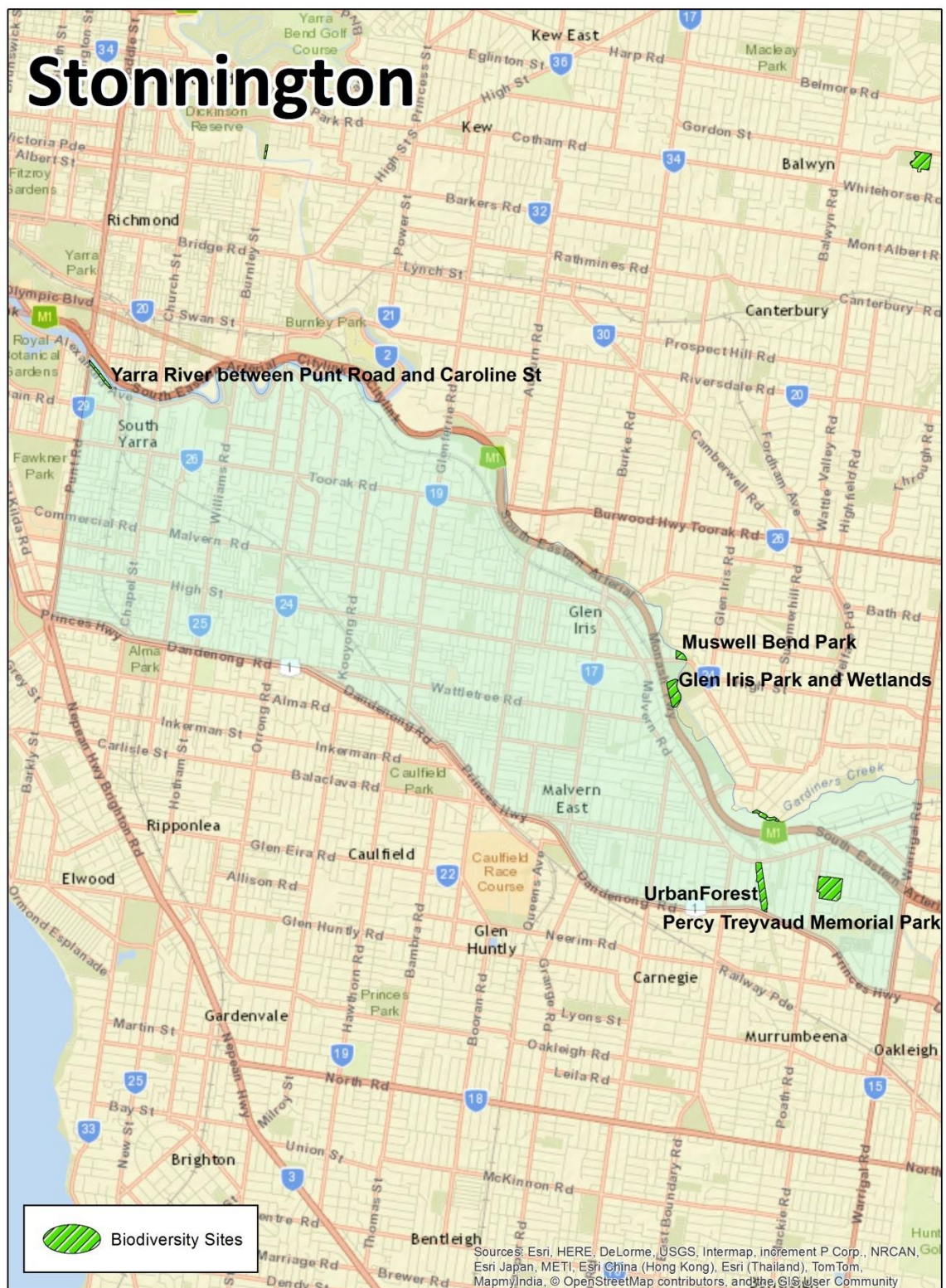


Figure 6. Survey sites in Stonnington municipality.

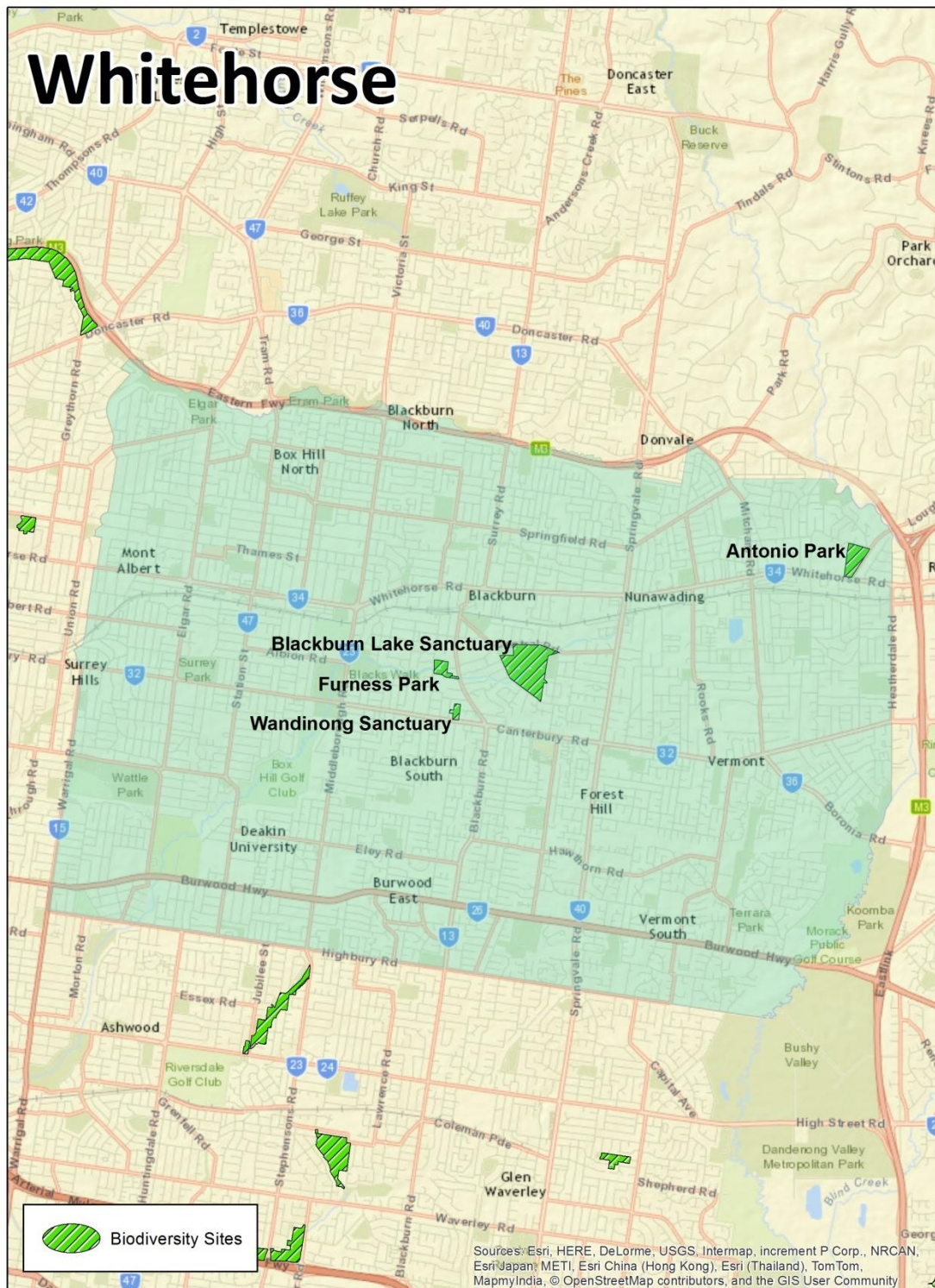


Figure 7. Survey sites in Whitehorse municipality.

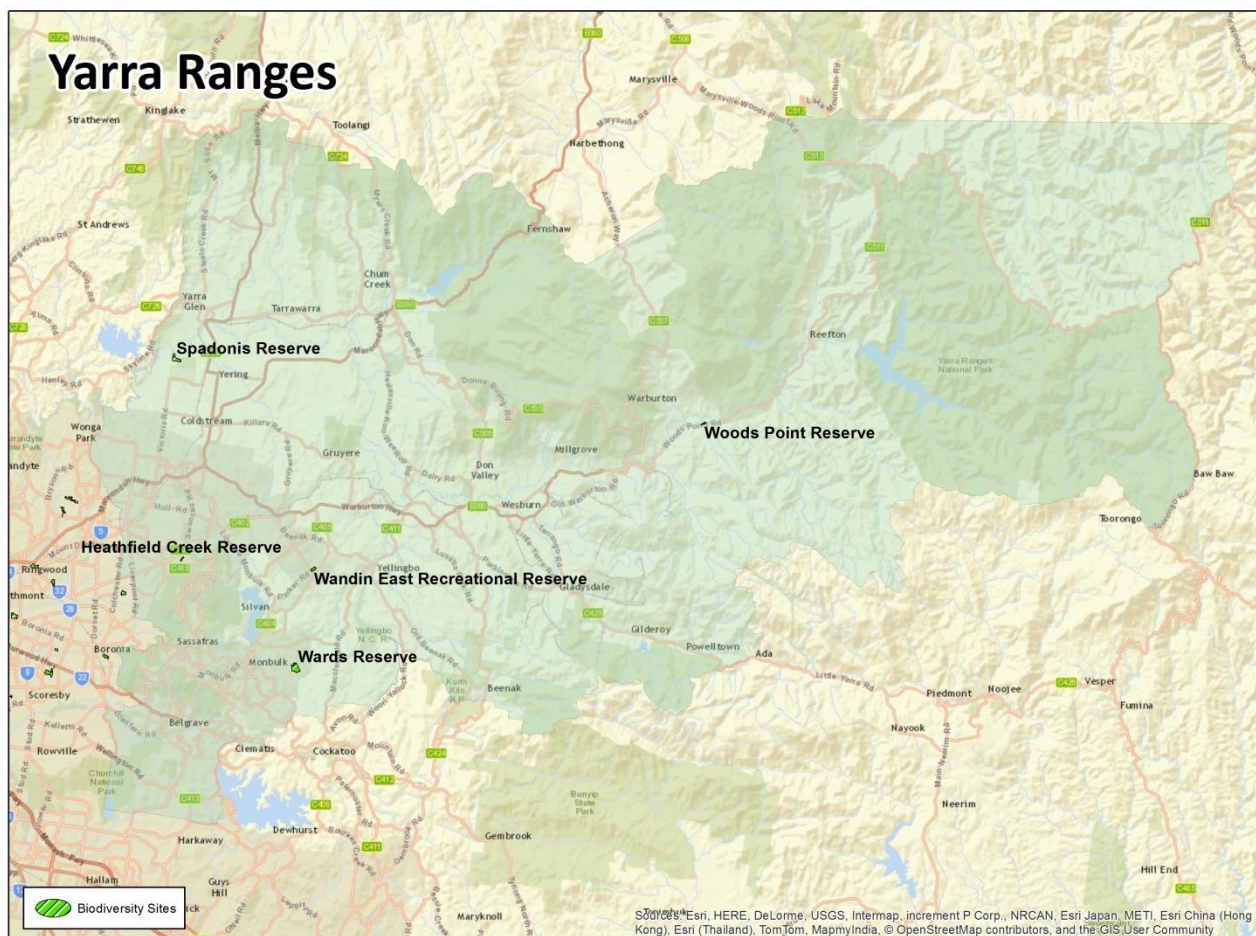


Figure 8. Survey sites in Yarra Ranges municipality.

Field Surveys

Field surveys for the EAGA project follow the standard BirdLife Australia survey protocol. These surveys are carried out over a 2ha area that is actively searched for birds over a 20 minute period. All birds seen within the 2ha area in this time period are recorded. Data obtained using this method is standardised, easily repeatable, and provides both species richness (number of bird species recorded) as well as abundance data.

Data from the BirdLife Australia Atlas project generally follows the same survey protocols (20min 2ha). The Atlas allows for additional survey methods which are generally comparable to the 2ha 20min surveys and as such have been incorporated into this project. For example searches done over a larger area (500m) or the entire sites over a time period <1hr have been included as the area and search effort and generally comparable to the 20min 2ha method. This inclusion increases the available data for analysis, giving more rigorous results. Data from e-bird which conforms to the survey protocols has also been included in the survey data for the EAGA project.

For all exploration and analysis of data in this report only survey data for the defined EAGA sites has been used.

Analysis

To look at changes in bird species over time a “reporting rate” has been used. This is a simple measure of calculating the probability of occurrence of a species at a site over time. The reporting rate is the proportion of all surveys during a desired time period (in this case 2015) at which a bird species is recorded as being present. Reporting rates do not consider the abundance (or population size) of a species, however Ehmke and Chambers (2010) have shown that for many species the reporting rate can act as a sound surrogate for population estimates, and trends determined using the reporting rate accurately reflect greater population trends in species.

The reporting rate is calculated using equation 1:

$$RR=n/S \quad \text{equation 1}$$

Where: RR = reporting rate

n = number of surveys where a species is recorded as present

S = total number of species.

The use of reporting rates (rather than strictly using abundance count data) has allowed for increased surveys to be included in this current report (as not all surveys undertaken by volunteers include count data). Another benefit is that this is a standardized method and can allow direct comparison between sites (or LGA’s) without requiring even survey effort.

Shannon Diversity Index

In this context “diversity” refers to not only the number of species recorded, but also the abundance of individuals recorded within each species (Spellerberg and Fedor 2003). To measure this, the Shannon Diversity index has been calculated for each site and LGA using the project data. This provides a standardised way of comparing the bird diversity between each of the EAGA sites, regardless of survey effort, as well as a long term measure of temporal changes in the bird communities at each site. Ideally management should aim to maintain or increase the index value over time. There is no one optimal value, as sites differ in size, habitat type, location within the urban matrix and connectivity to other habitat, all factors that influence the potential to support bird species. Indices should not be compared between sites (or LGAs), but seen as a way to track change over time. Climate (both short term events like droughts and longer term events such as climate change) will also contribute to changes in diversity values and must be considered when comparing temporal changes to determine if decreases (or increases) are caused by management activities or environmental factors.

The Shannon Diversity Index is a standard index regularly used in ecology. It is a measure that incorporates both species richness, as well as the proportion of all individuals that can be attributed to each species (evenness). For example, a survey may record 17 individuals from 2 species at a site. This could be 16 individuals of species 1 and 1 individual from species 2, or 8 individuals from species 1 and 9 individuals from species 2 (or any other combination totalling 17 individuals and 2 species). In the first instance, whilst 2 species are present, the actual population is dominated by a single species, which effectively reduces the diversity. The latter



example is considered more diverse as the actual total population is not dominated by one or the other species and consequently has a higher Shannon Index.

The Shannon Index is calculated by using equation 2:

$$H = - \sum_{i=1}^s p_i \ln p_i \quad \text{equation 2}$$

H = Shannon Value

p_i = the proportion of the i th species of the total number (n) of individuals recorded.

The higher the value of H the more diverse a site is considered to be.

Climate Change Species

Thirty-one bird species that occur within the EAGA region have been identified by ClimateWatch (<http://www.climatewatch.org.au/>) as being key species to monitor, as changes to their behaviour and/or phenology is likely to be in response to climate change. A list of these species is available in Appendix 2.

Breeding data is limited in availability for these species, however changes in seasonal or general presence of these species has been explored. All available data for each of these species recorded at the EAGA defined sites has been plotted for the time period 1998 to 2015. This allows for an exploration of potential seasonal changes or movements into the region over time.

Urban Sensitive Species

Threlfall *et al.* (2014) identified 38 species of birds that could be considered urban sensitive species. These species were derived from White *et al.* (2005) and Conole and Kirkpatrick (2011). A list of these species is available in Appendix 3. All available data for each of these species recorded at the EAGA sites has been pooled. For species with sufficient data reporting rates have been calculated and plotted for the period 1998 – 2015.

Results

Survey Uptake

One of the requirements for this project to be successful is the ongoing engagement with community members and BirdLife Australia members in the surveying of designated sites. Communication with three BirdLife Australia branches with members within the seven EAGA LGA areas (BirdLife Melbourne, BirdLife Yarra Ranges and BirdLife Southern Beaches) have been informed of the project through ongoing e-mail communication and presentations at branch meeting. General community members have attended workshops on bird identification and survey methodology.

The uptake of surveys for this project can be seen in Table 1. To date 122 surveys have been undertaken specifically for this project, across 28 of the 35 sites. Not all these surveys have conformed to the 20 minute survey protocol, and as such are not usable in the analysis. Seven survey participants, including the author of this report have undertaken these surveys. Some sites have shown repeat surveys by the same participant, which looks positive for the ongoing data collection at these sites. Other sites however have been ad hoc and may require further consideration on how to ensure sufficient bird data is collected. Data collected by council employees have not been included in the current analysis unless this data has been entered into the BirdLife Birdata database.

Combining the specific EAGA surveys with additional atlas and e-bird data, data was available for all but two of the EAGA sites. Sites Narr- Maen and Woods Point Reserve had no data for the study period. Table 1 shows the overall survey effort for EAGA sites across 2015-16 period that has been used for analysis in this report. Further information on sites can be found in Appendix 1.

Shannon Diversity Index

Across the EAGA region (Figure 1) a total of 97 bird species have been recorded at the designated survey sites in 2015 (Appendix 4) for complete list of species, where they were recorded and recording rate). This is 63% all species (153) recorded at these sites since 1998 (Australian Bird Atlas). A total of 6786 individual birds have been counted. Table 3 provides a breakdown of these landscape scale numbers across the seven EAGA local government areas, and individual sites within each LGA. Provided is also the calculated Shannon Diversity Index at the landscape, LGA and site scale.



Table 1 Survey effort for EAGA project and total surveys used in this report for the 2015 period

Site Name	EAGA Surveys	All Surveys (2015)
EAGA Antonio Park	18	18
EAGA Bateman Street Bushland	2	1
EAGA Beckett Park	1	2
EAGA Blackburn Lake		5
EAGA Bungalook Conservation Reserve East	9	9
EAGA Candlebark Reserve		1
EAGA Chandler Park Central	2	2
EAGA Damper Creek Reserve	6	6
EAGA Fairway Reserve	10	10
EAGA Furness Park		9
EAGA Glen Iris Park and Wetlands	3	6
EAGA Heathfield Creek Reserve	1	1
EAGA Hinkler Reserve	7	7
EAGA Koolunga Reserve	2	2
EAGA Koonung Creek Reserve	3	3
EAGA Lakewood Reserve	5	13
EAGA Mulgrave Reserve	6	6
EAGA Muswell Bend Park	3	3
EAGA Narr-Maen		0
EAGA Percy Treyvaud Memorial Park	6	6
EAGA Redcourt Reserve	3	3
EAGA Ringwood Lake		4
EAGA Roselyn Reserve	1	1
EAGA Ryburne Avenue Reserve	3	3
EAGA Spadonis Reserve		1
EAGA Urban Forest	3	3
EAGA Valley Creek Reserve	10	9
EAGA Walmer Street Extension	1	1
EAGA Wandin East Recreational Reserve	2	2
EAGA Wandinong Sanctuary	1	1
EAGA Wards Reserve Central	6	6
EAGA Wilsmere Park	2	6
EAGA Wombalano Park	3	2
EAGA Woods Point Reserve		0
EAGA Yarra River Bike Path	3	2
Total	122	154

Bird species richness ranges between 35 species recorded across sites in Boroondara to 62 species in Knox. Abundance counts vary between 435 (Boroondara) and 1724 (Knox). Both these values (species richness and individual abundance) are biased by the overall survey effort; note that in this instance, whilst Boroondara record the lowest numbers of species and individuals, both Yarra Ranges and Maroondah had less survey effort recorded, and whilst Knox had the most species and individuals recorded both Monash and Whitehorse had significantly more surveys undertaken. These biases are avoided using the standardised Shannon Diversity Index as a means to compare between LGAs and sites, as well as providing a baseline value for future surveys.

Table 3 Summary of the results for each Local Government Area and survey site across the 2015 survey period. Also included are the overall results for the EAGA region.

Local Government Area	Site Name	# surveys	#species	#individuals	Shannon Index
Boroondara		17	35	435	2.78
	EAGA Beckett Park	2	5	42	1.48
	EAGA Chandler Park Reserve	2	11	73	1.48
	EAGA Koonung Creek Reserve	3	17	87	2.52
	EAGA Ryburne Avenue Reserve	3	16	77	2.29
	EAGA Walmer Street Extension	1	5	14	1.13
	EAGA Wilsmere Park	6	29	142	2.80
Knox		20	62	1724	3.17
	EAGA Bateman Street Bushland	1	6	16	1.54
	EAGA Koolunga Reserve	2	15	70	2.41
	EAGA Lakewood Reserve	13	58	1511	3.08
	EAGA Redcourt Reserve	3	12	107	1.98
	EAGA Roselyn Reserve	1	7	20	1.57
Maroondah		16	50	744	3.23
	EAGA Bungalook Conservation Reserve East	9	17	91	2.49
	EAGA Candlebark Reserve	1	16	108	2.63
	EAGA Narr-Maen				
	EAGA Ringwood Lake	4	37	468	2.80
	EAGA Wombalano Park	2	17	77	2.48
Monash		38	42	1304	2.90
	EAGA Damper Creek Reserve	6	23	275	2.46
	EAGA Fairway Reserve	10	20	302	2.36
	EAGA Hinkler Reserve	7	16	214	2.32
	EAGA Mulgrave Reserve	6	23	272	2.79
	EAGA Valley Creek Reserve	9	21	241	2.55
Stonnington		20	47	1128	3.32
	EAGA Glen Iris Park and Wetlands	6	39	531	3.25
	EAGA Muswell Bend Park	3	20	60	2.74
	EAGA Percy Treyvaud Memorial Park	6	19	269	2.23
	EAGA Urban Forest	3	19	169	2.58
	EAGA Yarra River Bike Path	2	18	98	2.53
Whitehorse		33	50	1013	3.03
	EAGA Antonio Park	18	23	355	2.42
	EAGA Blackburn Lake	5	36	276	3.03
	EAGA Furness Park	9	25	359	2.71
	EAGA Wandinong Sanctuary	1	5	22	1.33
Yarra Ranges		10	46	438	3.26
	EAGA Heathfield Creek Reserve	1	15	53	2.47
	EAGA Spadoni's Reserve	1	25	110	2.92
	EAGA Wandin East Recreational Reserve	2	19	150	1.99
	EAGA Wards Reserve Central	6	19	125	2.64
	EAGA Woods Point Reserve				
EAGA Region			97	6786	3.55

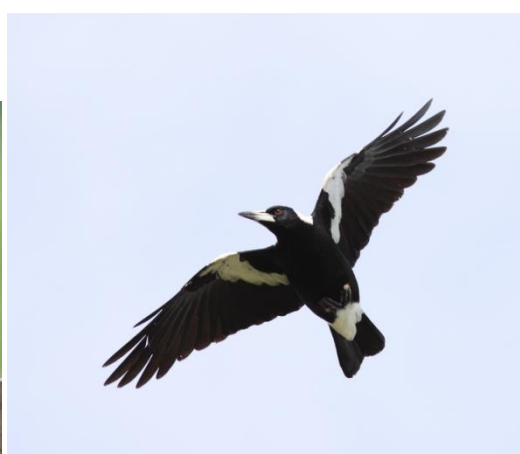
The Shannon indices show an overall landscape diversity value of 3.55. As a comparison, calculated Shannon indices for 2007, 2011 and 2013 were 2.98, 3.33 and 3.55 respectively. These years were selected as they had survey data for all seven LGA areas (except 2007 where no survey data was available for Yarra Ranges), as well as count data available for species. These results suggest that bird diversity has increased to a point where it is now remaining stable.

For each of the individual LGA's Stonnington is showing the highest biodiversity, even though Knox recorded the highest number of species and the highest number of individuals. This result is possible influences by the inclusion of the Glen Iris Park and

Wetlands as it includes a habitat type (wetlands) not necessarily present across all survey sites in all LGAs.

Monash, whilst having the highest survey effort and high abundance counts has a low Shannon index. This suggests that whilst 42 species have been recorded, which is higher, or equitable to other LGA's, the abundance of individuals in some species is disproportionately higher than others. Exploration of the data found that in this instance five species of birds (or 11% of species recorded; Australian Magpie *Cracticus tibicen*, Rainbow Lorikeets *Trichoglossus haematodus*, Noisy Miner *Manorina melanocephala*, Red Wattlebird *Anthochaera carunculata* and Spotted Dove *Streptopelia chinensis*) account for over 60% of the individual birds recorded across surveys. Similarly Boroondara, which has the lowest Shannon score, has two species (Noisy Miner and Rainbow Lorikeet) dominating the abundance counts. The spread of these species can be seen in Figures 11 - 18

Spotted Doves and Magpies are amongst the most common birds seen across the EAGA region



These plots (Fires 10, 11-18), whilst designed to identify common species (see below for further information), can also provide a way to visualise the “evenness” and structure in bird communities. Two distinct configurations emerge across the seven LGA's. The first, across Boroondara, Monash, Stonnington and Whitehorse, shows a linear progression (confirmed by the high R^2 values) from low reporting rate/low abundance species (uncommon species) to high reporting rate/high abundance species (Common Species). This is the general trend seen across the EAGA landscape as a whole (Figure 10). The second community configuration, seen across Knox, Maroondah and Yarra Ranges shows a much more even abundance in species regardless of how frequently they are encountered. These trends highlight what is meant by the term “evenness” and how it relates to the bird diversity. Stonnington, which has the highest calculated diversity index, has a high proportion of uncommon species (low reporting rate and low abundance). There is a continuum of birds recorded at increasing frequency and increasing abundance across the study sites, culminating in few widespread and highly abundant species.

Comparatively, the remaining three LGA's that show this community configuration (Boroondara Monash and Whitehorse), show a very distinct separation of the high frequency high abundance species and low frequency, low abundance species. The mid-range species seen in the Stonnington graph are missing - that is birds in Boroondara,

Monash and Whitehorse are either recorded across few surveys in low numbers or all surveys in high numbers.

The three LGA's that show trend two also have the higher calculated diversity indices. There is much more evenness in the bird species abundances, which leads to a higher Shannon index. Why these two trends occur will require further investigation. It is interesting however that there is a geographic split between these two groups, which possibly reflects the urbanisation of the LGA's. It will be interesting to see if the community structure changes as the eastern LGAs (in particular Yarra Ranges) become more urbanised, however consideration should be given to the management of these areas to minimise this.

At the site level, much greater variation in the diversity can be seen. The sites with the highest indices such as Glen Iris Park and Wetland, Lakewood Reserve, Blackburn Lake and Spadoni's Reserve have a variety of habitat types, including wetlands, waterbodies and woodland habitat, which can support increased species richness. These also tend to be some of the larger, or less isolated reserves, however there is no direct relationship between diversity scores and area per se (Figure 9).

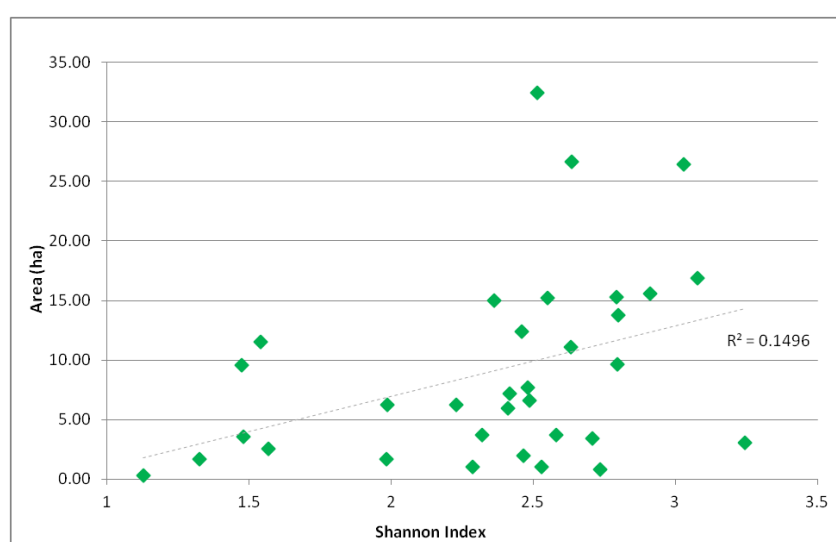


Figure 9 Scatter plot of Shannon Index against Site Area. The linear trend (broken grey line) does not show a good fit to the points as demonstrated by the low R^2 value.

At the lower end of the diversity index are Wandinong Sanctuary and Beckett Park which are smaller (see Appendix 1), isolated remnants, for example Wandinong Sanctuary is a small isolated patch of remnant woodland, surrounded entirely by residential properties. Whilst these properties tend to retain a tree cover, other habitat structures are missing, which is reflected in the bird species recorded at this site. Other sites such as Walmer Street Extension and Chandler park, whilst part of larger corridors, are areas with high levels of modification in the retained habitat. For example much of Chandler Park and the areas adjacent to Walmer Street extension is open, maintained grass. These areas with remnant canopy cover but expanses of open areas, is habitat favoured by Noisy Miners. This is an aggressive bird species that lives colonially,

excluding a number of smaller, less aggressive bird species. Subsequently bird communities end up dominated by Noisy Miners and the few other bird species that are able to persist alongside this species. This in turn reduces both the species richness and the evenness in the abundance of species, lowering the index values.

Common Species

Birds that are encountered on a regular basis are generally referred to as “common” species. There are two components that contribute to this – the abundance of a bird species (how many are there?) and how frequently it is seen (is it found in lots of places or only a few?). Common species are high in numbers and found in a lot of places. In urban environments these species tend to be larger, aggressive species that can begin to dominate the remaining habitat, excluding smaller less common species, leading to reductions in bird species diversity and the loss of species for the general landscape. Figure 10 shows a plot of the reporting rate (x-axis) against the abundance (y-axis) for each species recorded across the EAGA region. Across the study region Noisy Miner, Red Wattlebirds, Rainbow Lorikeets and Australian Magpies tend to be the most common bird species recorded. A second group of species comprising Little Raven *Corvus mellori*, Spotted Dove, Brown Thornbill *Acanthiza pusilla* and Common Blackbird are species that are still quite abundant, but not as widespread as the most common species. Common Starlings *Sturnus vulgaris* and Musk Lorikeets *Glossopsitta concinna* tend to be locally common – that is they are not necessarily widespread across the entire study region, but at those places where they are found they are in high numbers.

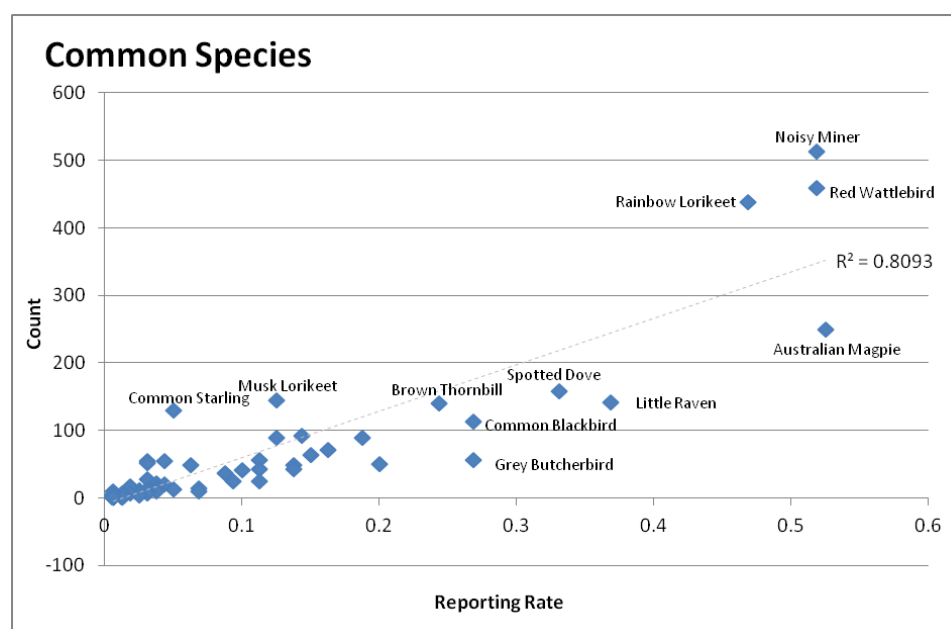
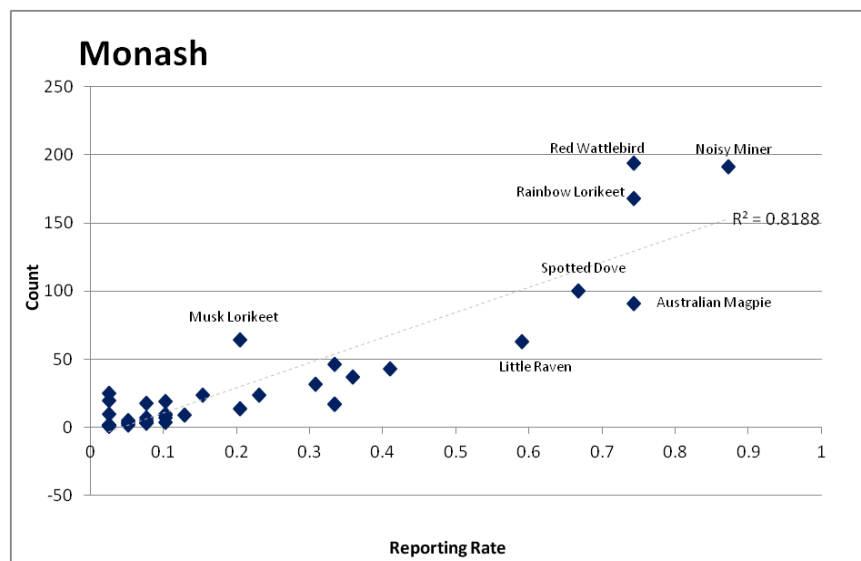
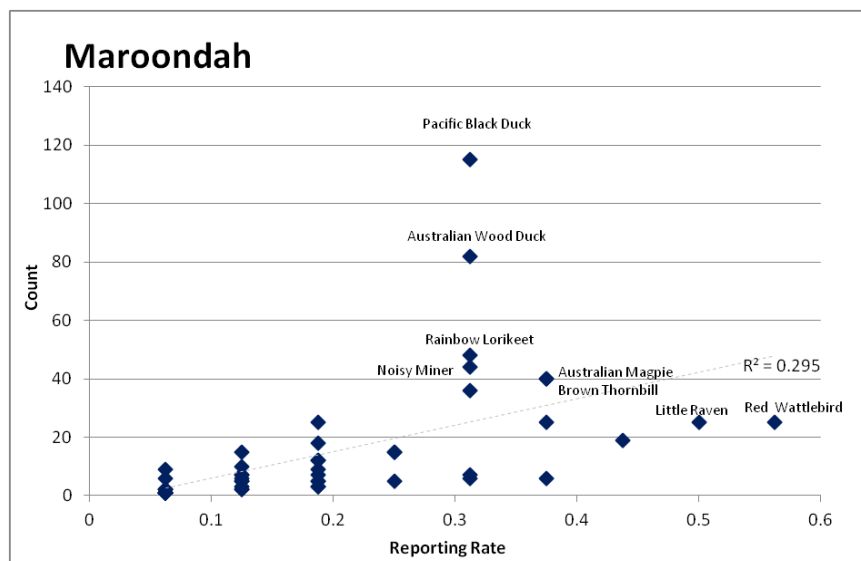
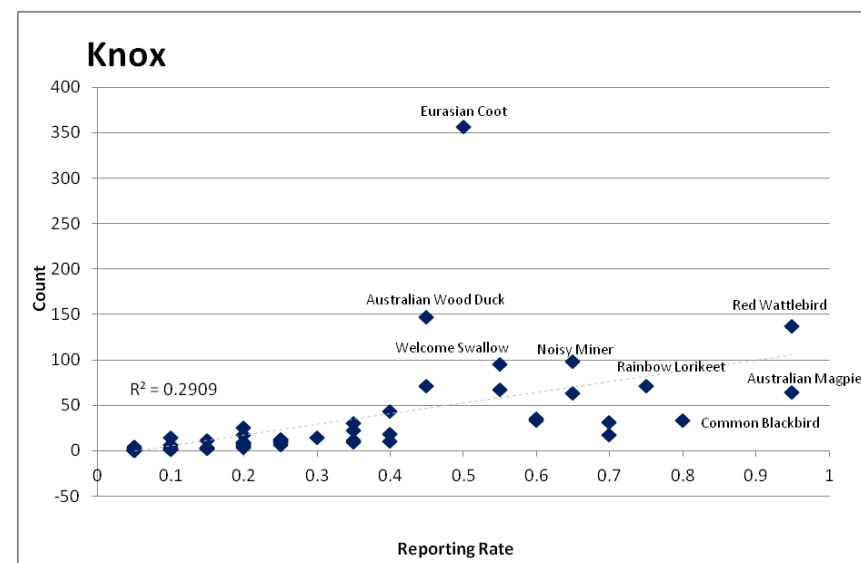
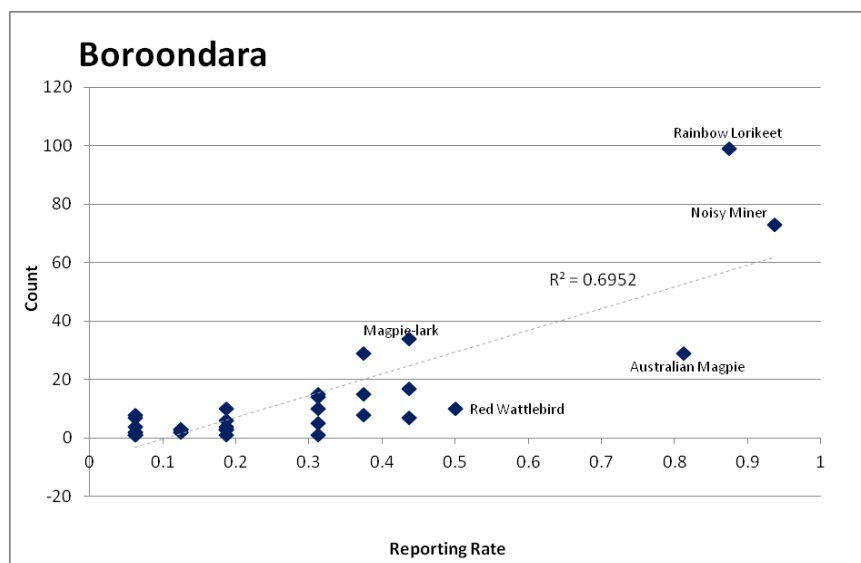
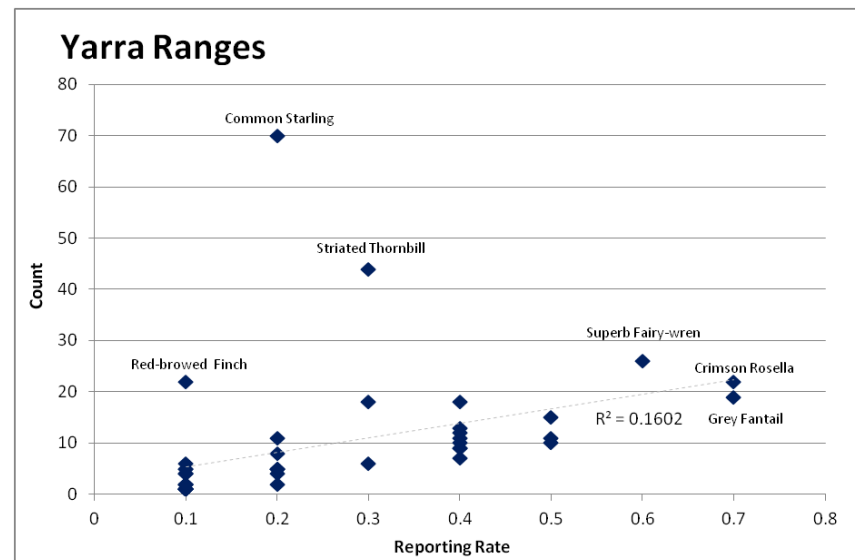
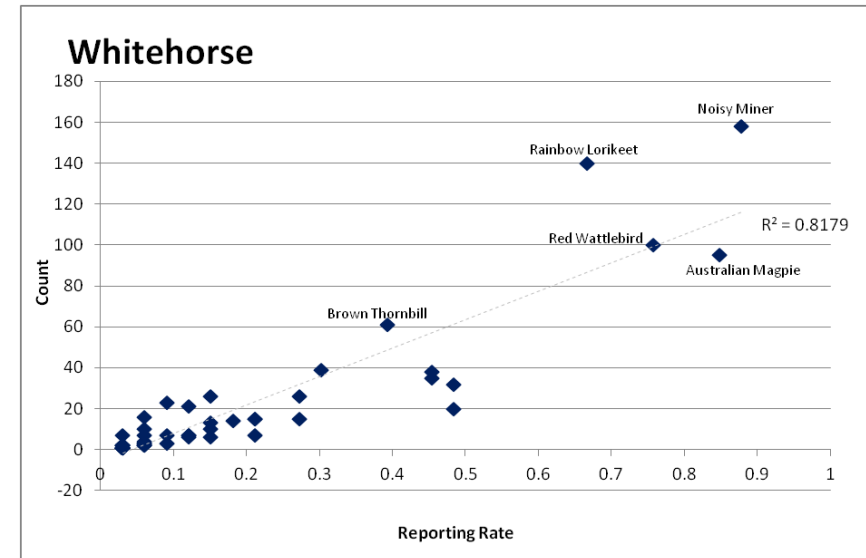
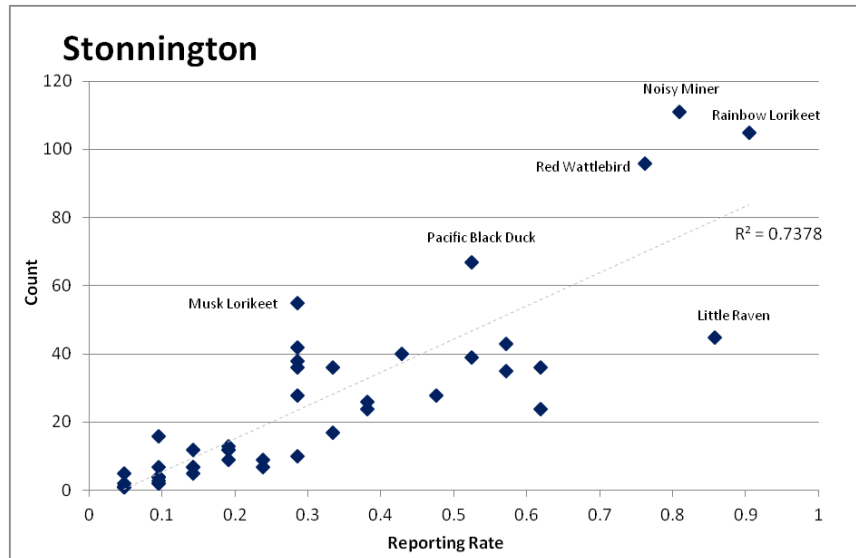


Figure 10 Bird community across EAGA region. The plot shows the relationship between frequency of occurrence (Reporting Rate) and abundance. Bird species that sit to the far right top corner of the plot are the most common species. Data for 2015 surveys.

Figures 11 - 18 show similar plots for each of the LGA's. Across Boroondara, Monash, Whitehorse and Stonnington, and to a lesser extent Knox, Noisy Miners, Red Wattlebirds, Rainbow Lorikeets and Australian Magpies dominate the bird communities. For the remaining LGA's these species, whilst present, show slightly different trends. For example in Maroondah Red Wattlebirds are the most frequently encountered species, however Noisy Miners and Rainbow Lorikeets are much more abundant. This suggests that these two species are locally common – that is whilst not recorded across all sites, where they are recorded they are in high numbers. Interestingly, none of the bird species dominating the assemblages in other LGA's appear to be the most abundant or most frequently encountered species in the Yarra Ranges. In fact, surveys to date across the Yarra Ranges sites show a very different avian assemblage in this LGA compared to the others. Grey Fantails *Rhipidura fuliginosa*. Crimson Rosellas *Platycercus elegans* and Superb Fairy-wrens *Malurus cyaneus* are the most frequently encountered but not the most abundant species. Fewer surveys have been undertaken across the LGA at this time than other areas which will influence total count data.



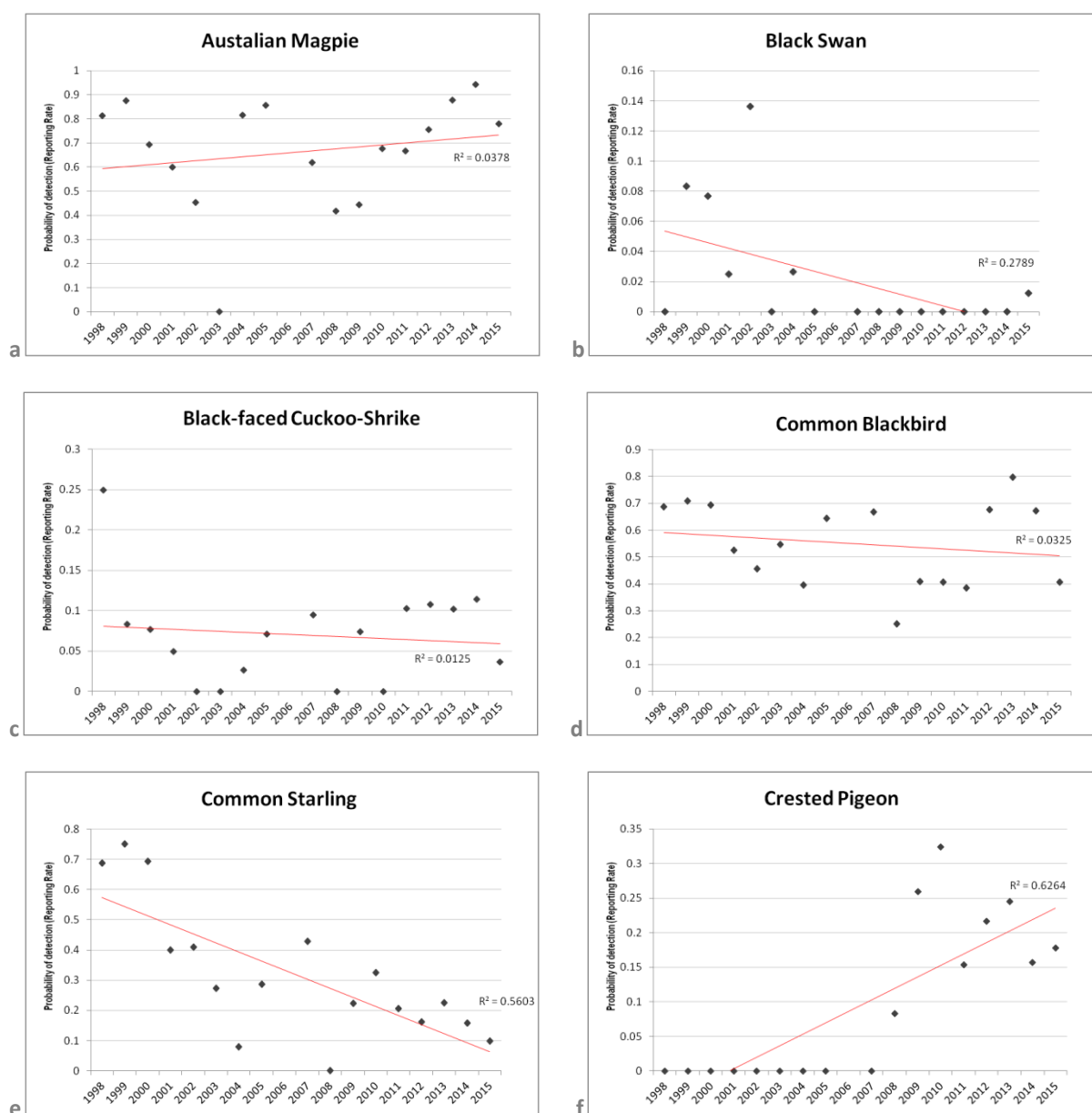
Figures 11 - 18 Scatter plots of bird species across each of the seven LGAs. Those LGA's with higher Shannon Indices tend to show a more even spread of species and abundance. Common species are identified, data for 2015 surveys.



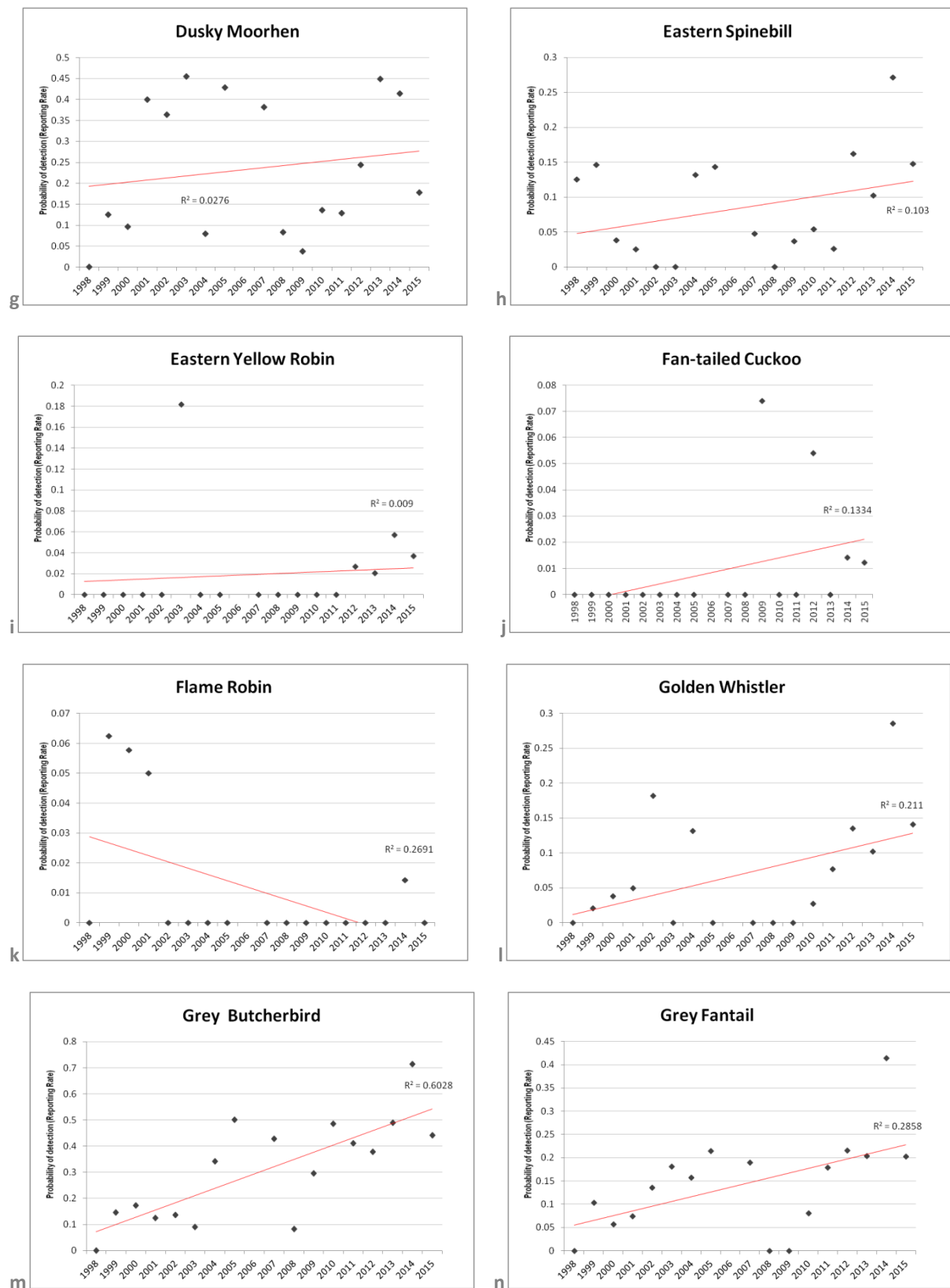
Figures 11 - 18 Scatter plots of bird species across each of the seven LGAs. Those LGA's with higher Shannon Indices tend to show a more even spread of species and abundance. Common species are identified, data for 2015 surveys.

Climate Change Species

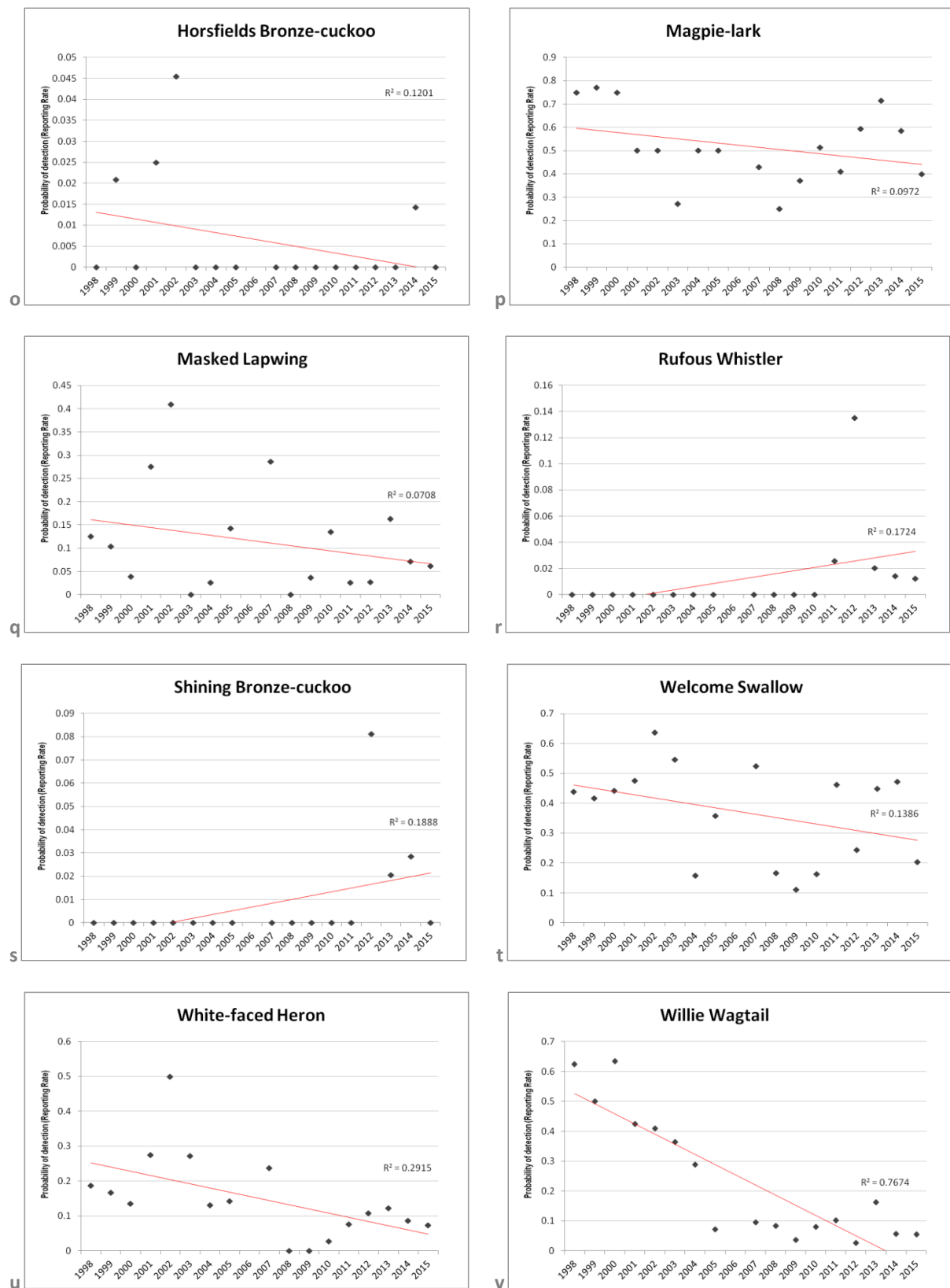
Reporting rates for the ClimateWatch species (<http://www.climatewatch.org.au/>) were pooled across the seven EAGA LGA's, with annual reporting rates calculated for the period 1998 – 2015. Analysis was undertaken at this scale to ensure sufficient standardised survey effort across the sites. Each of the 23 species with sufficient data has been plotted below (Figures 19a-w). For most species reporting rates over time show no distinct trend, with reporting rates being highly variable (or records of species so low that no discernible trend can be determined). Four species show very strong trends – Common Starling, Crested Pigeon *Ocyphaps lophotes*, Grey Butcherbird *Cracticus torquatus* and Willie Wagtail *Rhipidura leucophrys*.



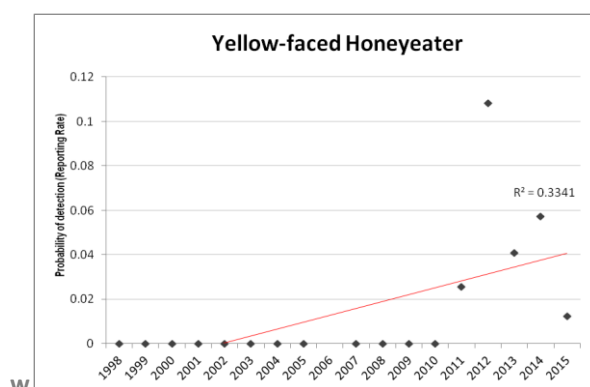
Figures 19 a-f. Plot of annual reporting rates (navy points) for bird species identified as potential climate change indicators. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.



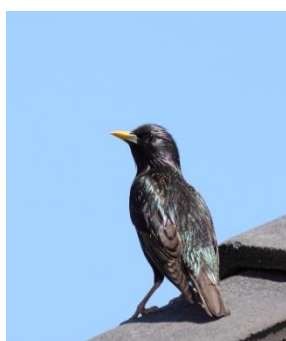
Figures 19g-n. Plot of annual reporting rates (navy points) for bird species identified as potential climate change indicators. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.



Figures 19o-v. Plot of annual reporting rates (navy points) for bird species identified as potential climate change indicators. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.



Figures 19w. Plot of annual reporting rates (navy points) for bird species identified as potential climate change indicators. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.



Common Starlings are showing a pronounced decline in their occurrence across the EAGA region. There is a good linear fit ($R^2 = 0.5606$), and as this bird is introduced and can be detrimental to native species; they actively compete and exclude native bird species from limited nesting hollows and once occupied the Starlings can defoul sites making them unsuitable for native species for extended time periods (HANZAB 2006), it is positive that this species is declining. Starlings show remarkable synchrony of laying dates (HANZAB 2006), which is why it has been selected as a climate change indicator. Looking at Table 4, which plots

the monthly records for this species, no seasonal trends or changes seem to be occurring.

Table 4. Calendar of positive records for the Common Starling across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998									+	+	+	+
1999		+	+	+	+	+	+	+	+	+	+	+
2000	+	+	+	+	+	+	+	+	+	+	+	+
2001	+	+	+	+	+	+	+		+		+	+
2002		+		+				+		+	+	+
2003										+	+	+
2004	+		+									
2005								+	+	+		
2006	+	+										+
2007	+			+					+	+	+	
2008												
2009	+		+		+				+	+		
2010		+	+		+		+	+				+
2011			+		+		+		+		+	+
2012		+							+	+	+	
2013						+	+		+	+	+	+
2014	+		+	+			+	+	+		+	+
2015	+			+	+	+	+	+	+		+	+
2016												



Crested Pigeons were not recorded at any of the survey sites until 2008. The species is believed to have expanded its pre-European range in response to drought events, with the species first appearing in Bacchus Marsh in the 1980's, before moving further east into metropolitan Melbourne. Other evidence suggests that the movement of the species is more reflective of habitat modification and agriculture rather than strictly climate (Chambers *et al.* 2005; Dooley 2014). Crested Pigeons were not regularly recorded across

the eastern suburbs of Melbourne until around 2002. They are now well established and one of the more commonly recorded species. Table 5 presents the seasonal spread of the survey data for the Crested Pigeon. This species does not show any seasonal trends in its occurrence, however it is clear that this species was not recorded at any of the EAGA survey sites until late 2008.

Table 5. Calendar of positive records for the Crested Pigeon across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999												
2000												
2001												
2002												
2003												
2004												
2005												
2006												
2007												
2008												+
2009	+		+	+		+		+	+	+		
2010		+	+		+		+	+				
2011			+		+		+		+			
2012	+	+	+						+	+	+	
2013	+		+			+			+	+		+
2014	+	+	+		+	+		+		+	+	+
2015	+	+	+	+	+	+	+	+	+		+	
2016	+											



Grey Butcherbirds are showing an increase in their reporting rates. Again, this is a highly linear trend ($R^2=0.6028$). Grey Butcherbirds are a species of bird that have readily adapted to habitat modification and urbanisation, and are considered as potentially disruptive to avian community dynamics as it is a "broad-spectrum" competitor and nest predator (Catterall *et al.* 2010). Across Table 6 there are no apparent seasonal changes, however the increase in the frequency of records are apparent from 2013 onwards.

Table 5. Calendar of positive records for the Grey Butcherbird across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999						+	+	+		+	+	+
2000			+	+		+	+	+	+	+	+	
2001	+				+				+		+	
2002		+		+			+					
2003		+										
2004	+		+	+	+	+	+		+	+	+	+
2005		+	+					+	+	+		
2006	+											+
2007	+			+			+		+	+	+	
2008												+
2009	+	+	+		+	+			+	+		
2010	+	+	+		+	+	+	+			+	
2011	+		+	+	+	+	+		+	+		
2012		+	+	+	+	+			+	+	+	+
2013	+	+	+	+	+	+	+	+	+	+	+	+
2014	+	+	+	+	+	+	+	+	+	+	+	+
2015	+	+	+	+	+	+	+	+	+	+	+	+
2016	+											



Willie Wagtails are the fourth species to show a distinct trend in occurrence rates. This species is showing a decline in occurrence rates ($R^2=0.7674$). It looks as though there was a steep decline in the species until 2005, but the species has stabilised in the past decade at a much reduced level. It is not possible to tell if the Willie Wagtail population was artificially inflated prior to 2005 and the decline was the population returning to more natural levels, or if the population has stabilised at much lower levels than should be naturally occurring. This species is worth keeping an eye on, particularly if the

decline can be attributed to increasing urbanisation or management. Major *et al.* (1996) found that increasing numbers of Pied Currawong *Strepera graculina*, in response to changing urban environments, reduced the longterm viability of Willie Wagtail populations across urban areas. This was mainly through the direct predation of eggs in Willie Wagtail nests. There is a strong statistically significant negative correlation between the reporting rates of these two species ($r = -0.610$, $n=18$, $p<0.01$, Pearsons Correlation, two-tailed) for the current project. This suggests that as Pied Currawongs have gone up Willie Wagtails have gone down, however further exploration should occur to determine if Pied Currawongs are the cause of this decline.

The decline in Willie Wagtails can also be observed in Table 6 where initially the species was recorded monthly. These records become much more sporadic from 2005 onwards. There are no obvious seasonal effects in the monthly records.

Table 6. Calendar of positive records for the Willie Wagtail across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998									+	+	+	+
1999		+	+	+		+	+	+	+	+	+	+
2000	+	+	+	+	+	+	+	+	+	+	+	+
2001	+	+	+	+	+	+	+		+		+	+
2002	+	+		+				+	+	+	+	+
2003		+								+	+	+
2004	+	+	+	+		+	+		+	+	+	
2005		+										
2006		+										
2007	+			+								
2008												+
2009	+											
2010				+		+						+
2011			+								+	+
2012										+		
2013	+	+	+							+		+
2014				+			+		+			
2015	+		+	+	+		+	+	+		+	
2016												

Of the remaining climate change species, nine show interesting seasonal trends, changes to which may be in response to changing climatic conditions. These changes may be either change in the months found to be present, obvious seasonal patterns, or temporal changes over the study period.

Black-faced Cuckoo Shrike *Coracina novaehollandiae* is a well known seasonal migrant, or partial migrant². The species tends to move north to northern Australia and New Guinea in autumn, returning to the south-east during spring and summer to breed (Higgins *et al.* 2006). Table 7 which presents the presence records for this species shows that records for the Black-faced Cuckoo-shrike across the EAGA sites reflects this expected behaviour. The species is recorded as present most years through September to March, with an obvious lack of records in April – August. 2014 sees the recording of this species in April and again in July and August, 2015 has the species present throughout May-June. As the climate warms, the persistence in the landscape of the Black-faced Cuckoo-shrike may be a result of milder winter weather.



² Partial migrants are species where are part of the population migrates, but a part of the population seems to remain resident

Table 7. Calendar of positive records for the Black-faced Cuckoo-shrike across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998									+	+	+	
1999									+		+	+
2000			+	+								+
2001	+											+
2002												
2003												
2004												+
2005		+										
2006												
2007									+			
2008												
2009									+	+		
2010												
2011			+							+	+	
2012									+	+	+	
2013									+	+	+	+
2014				+			+	+	+			+
2015	+				+	+		+	+		+	
2016	+											

Eastern Spinebills *Acanthorhynchus tenuirostris* are believed to be partial migrants (Chan 2001). They are considered partial altitudinal migrants in parts of south-eastern Australia (Higgins *et al.* 2001), and the trends seen in Table 8 fit with this across the EAGA sites. Most records for this species are across the winter months, suggestive of individuals of this species moving into the warmer urban areas during the winter. Exactly where birds move to after overwintering in Melbourne is not known, however it is likely that they disperse across their larger range, following flowering events throughout the Spring and Summer. Historic records show great influxes in this species in the north-east corner of NSW between April and September (Keast 1968).



Table 8. Calendar of positive records for the Eastern Spinebill across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998											+	+
1999		+				+		+				
2000			+				+					
2001							+					
2002												
2003												
2004					+	+	+	+	+			
2005	+		+									
2006		+										
2007									+			
2008												
2009					+							
2010					+			+				
2011							+					
2012			+		+	+				+		
2013							+		+	+		
2014			+	+	+	+	+	+	+			
2015				+	+	+	+	+	+			
2016	+											

Eastern Yellow Robins *Eopsaltria australis* are included (Table 9) here as it appears this species may be returning to the EAGA landscape after an extended absence. This species is generally a resident species and has been in decline across the greater Melbourne region (K. Herman unpublished data).



Table 9. Calendar of positive records for the Eastern Yellow Robin across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999												
2000												
2001												
2002												
2003								+	+			
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011												
2012												+
2013										+		
2014							+		+		+	
2015						+	+		+			
2016												

Flame Robins *Petroica phoenicea* (Table 10) are altitudinal migrants, moving to lower altitudes during the winter. Whilst they have never been an abundant species, they appear to have completely dropped out of the bird communities across the EAGA region since early 2000's. This could reflect changes to habitat in urban areas resulting in no suitable habitat for this species, or could be reflective of climate change. There is some evidence that the changing alpine climate is influencing migration patterns in this species, with birds returning earlier to alpine areas (Green 2006, Green 2010), but the relationship is complex and barely understood (Garnett *et al.* 2011). We simply don't know. Previous studies have found this species to be over-represented among species showing declines and may be an early indicator of climate change (Olsen *et al.* 2003 in Chamber *et al.* 2005).



Table 10. Calendar of positive records for the Flame Robin across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999						+	+					
2000						+	+	+				
2001							+					
2002												
2003												
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011												
2012												
2013												
2014				+								
2015												
2016												

Both the Golden Whistler *Pachycephala pectoralis* (top image) and Rufous Whistler *Pachycephala rufiventris* have been described as migratory, partial migrants or resident, depending on the geographic location of the population (Chan 2001). From Tables 11 and 12 both these species show seasonal effects in their presence across the EAGA sites. Golden Whistlers are much more prolific during the cooler months, being replaced by Rufous Whistlers in the Spring and Summer. As temperatures increase with the changing climate it will be interesting to see if there are changes to the seasonal presence of these two species.

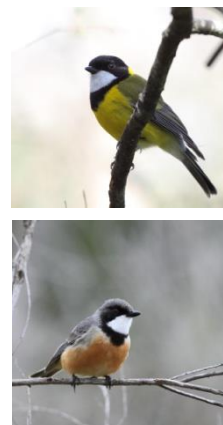


Table 11. Calendar of positive records for the Golden Whistler across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999				+								
2000			+			+						
2001					+							
2002				+					+	+	+	
2003												
2004				+	+	+	+					
2005												
2006												
2007												
2008												
2009												
2010					+							
2011					+	+						
2012					+				+	+	+	+
2013	+	+					+	+	+			
2014			+	+	+	+	+	+	+			
2015			+	+	+	+	+	+	+	+		
2016												

Table 12. Calendar of positive records for the Rufous Whistler across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999												
2000												
2001												
2002												
2003												
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011			+									
2012										+	+	+
2013										+		
2014											+	
2015	+									+		
2016												

Shining Bronze-cuckoos *Chalcites lucidus* (left image) and Horsfields Bronze-cuckoos *Chalcites basalis* are Spring migrants to Melbourne (Table 12). There has been some anecdotal evidence that cuckoos in general are changing their migratory patterns, with Common Koels being recorded in areas where they have not historically been recorded, and changes to the timing of the arrival of other cuckoo species. There also appears to have been a switch in the Bronze-cuckoo species recorded across the EAGA sites over time.



Table 12. Calendar of positive records for the Bronze-cuckoos across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month. HB indicates Horsfield's Bronze-cuckoo records and SB indicates Shinning Bronze-cuckoo records.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998												
1999										HB		
2000												
2001											HB	
2002										HB		
2003												
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011												
2012										SB	SB	
2013										SB		HB
2014											SB	SB
2015												
2016												

For the remaining species, that tend to be frequently recorded there is no discernible pattern in their presence across the study sites between years. Table 13 shows what the Australian Magpie looks like, with other species very similar in their spread.

Table 13. Calendar of positive records for the Australian Magpie across the EAGA region 1998 – 2015/16. Blue squares indicate months without survey data, green squares indicate months where survey data is available, + indicates species was recorded for that month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998									+	+	+	+
1999	+	+	+	+	+	+	+	+	+	+	+	+
2000	+	+	+	+	+	+	+	+	+	+	+	+
2001	+	+	+	+	+	+	+	+	+	+	+	+
2002	+	+	+	+	+		+		+	+		+
2003												
2004	+		+	+	+	+	+	+	+	+	+	+
2005	+	+	+					+	+	+		
2006	+	+	+									+
2007	+			+			+		+	+	+	
2008					+						+	+
2009	+	+	+	+	+	+			+	+		
2010		+	+	+	+	+	+	+	+		+	+
2011	+	+	+	+	+	+	+		+		+	+
2012	+	+	+	+	+	+	+		+	+	+	+
2013	+	+	+	+	+	+	+	+	+	+	+	+
2014	+	+	+	+	+	+	+	+	+	+	+	+
2015	+	+	+	+	+	+	+	+	+	+	+	+
2016	+											

Urban sensitive species

A list of 38 urban sensitive species has been developed from Conole and Kirkpatrick (2011) and White *et al.* (2005). Of these species there were records for 30 across the EAGA survey sites for the period 1998-2015. As expected of urban sensitive species these data are extremely limited across urban environments.

Figure 20 plots the survey effort against the number of urban sensitive species recorded within each of the LGAs. It can be seen that increasing survey effort leads to an increase in the recording of these rarer species, except in the case of Yarra Ranges LGA (shown on figure with green dot). This LGA has the lowest survey effort of all areas, but a high count of urban sensitive species. This suggests a less urbanised, intact landscape across this LGA.

Table 14 provides a summary of the number of records for each urban sensitive species across each municipality. This data is pooled over the period 1998-2015. The low frequency of counts for these species across the EAGA sites, over a 17 year period, further highlights the rarity of these species in urban environments. For distribution of species across sites see Appendix 3.

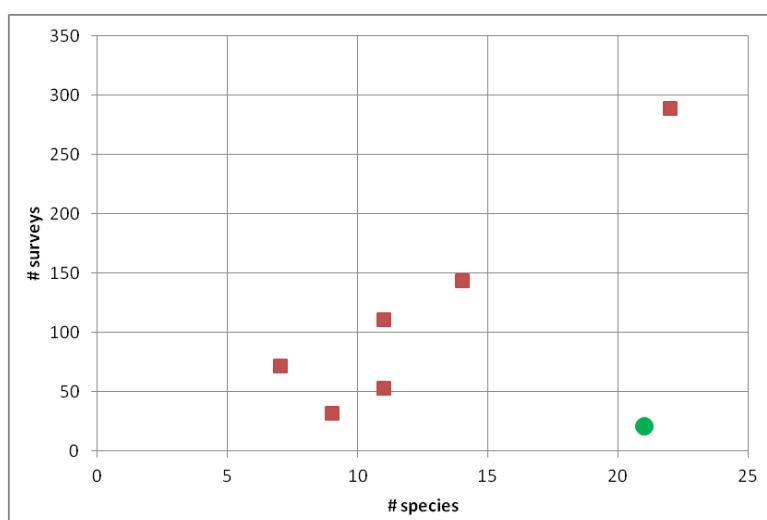


Figure 20 Plot of number of urban sensitive species against survey effort across each LGA. Green spot represents Yarra Ranges LGA.

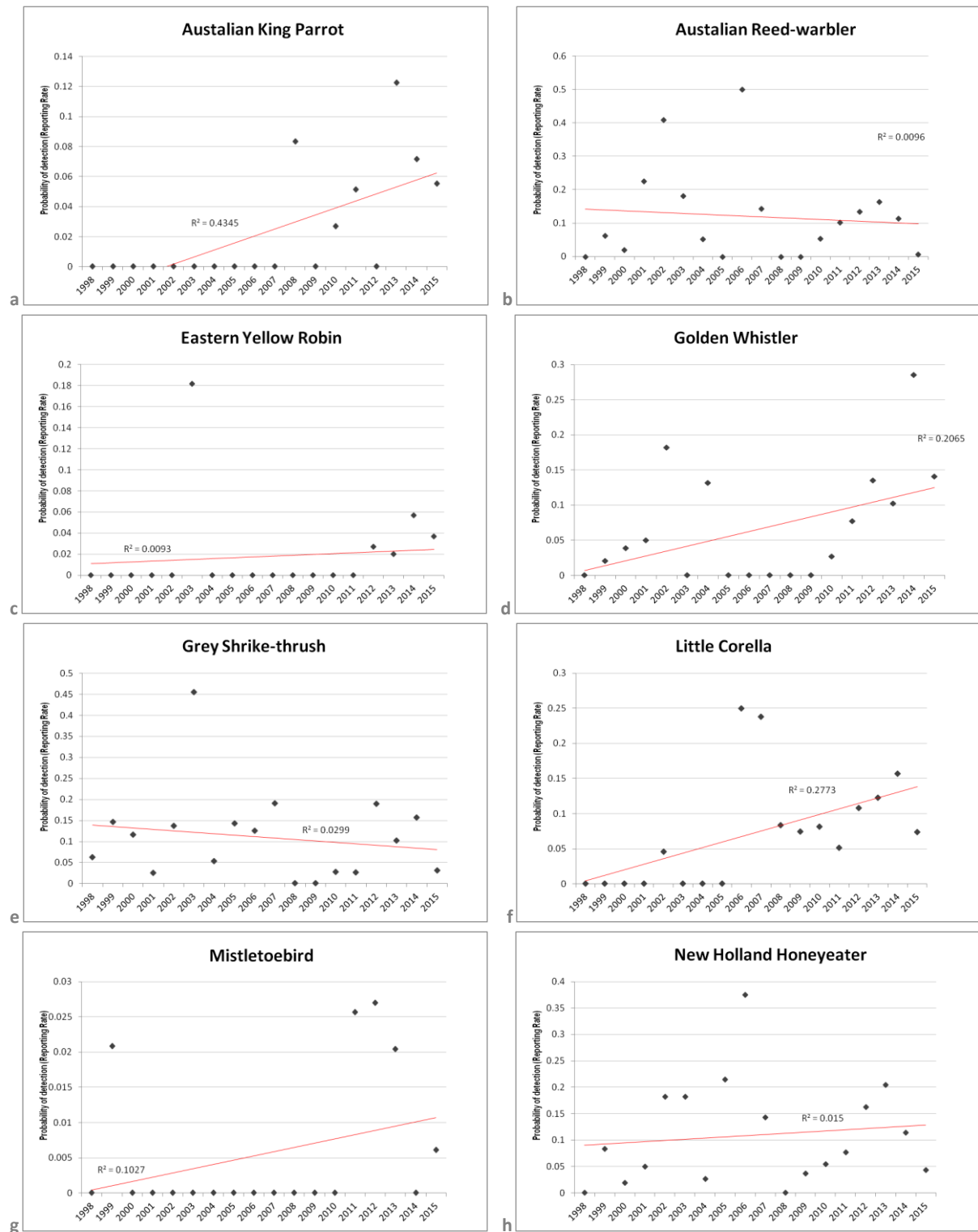
Figures 20a-n present the reporting rates for 14 urban sensitive species. These figures are limited to those species that have data for five or more years across the 1998-2015 period. Generally these species are erratic in their occurrence, however species such as New Holland Honeyeaters *Phylidonyris novaehollandiae*, Australian Reed-warblers *Acrocephalus australis*, Grey Shrike-thrush *Colluricincla harmonica* and Red-browed Finch *Neochmia temporalis*, are consistently recorded across the 17 year period. Australian King Parrots *Alisterus scapularis* appear to be increasing in their frequency. Yellow-faced Honeyeaters *Lichenostomus chrysops* and Sacred Kingfishers *Todiramphus sanctus* also show an increasing frequency in occurrence, however this may be the result of survey effort rather than increases in the birds (See Appendix 5 for annual surveys within each LGA).



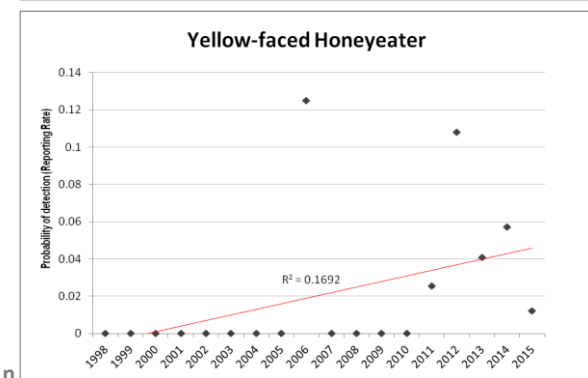
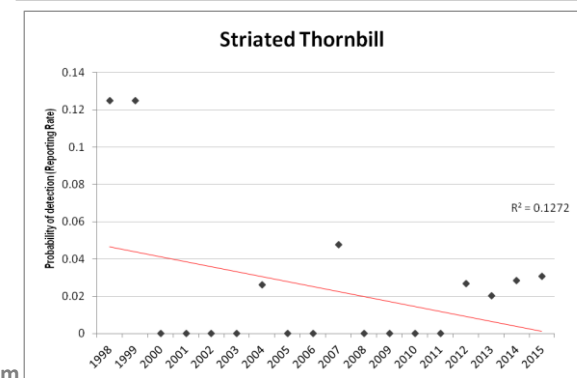
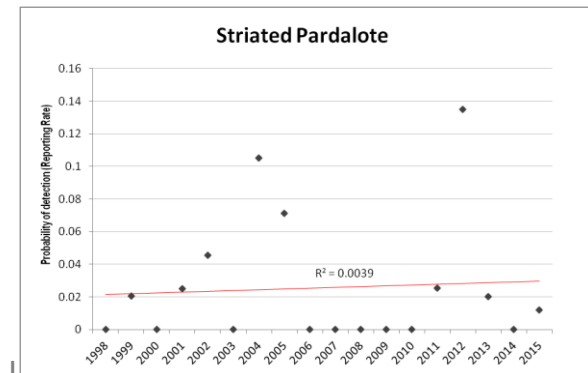
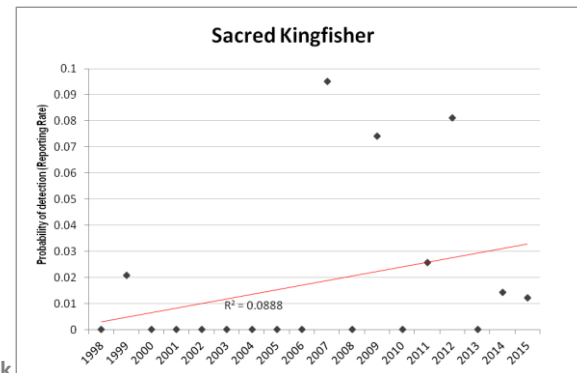
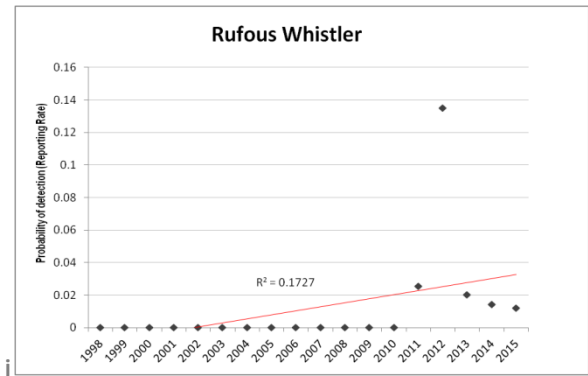
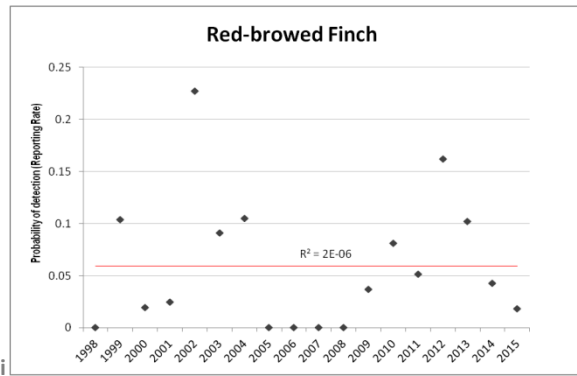
Images are of birds as listed in text. New Holland Honeyeater, Australian reed-warbler, Grey Shrike-thrush, red-browed Finch, Australian King Parrot, Yellow-faced Honeyeater and Sacred Kingfisher.

Table 14. Summary of urban sensitive species records across the seven EAGA municipalities. Reporting Rate is for each species across the EAGA landscape. Data pooled 1998-2015.

	Reporting Rate	Boroondara	Knox	Maroondah	Monash	Stonnington	Whitehorse	Yarra Ranges	Grand Total
Australian King-Parrot	0.0338		3	4	4		12	2	25
Australian Reed-Warbler	0.0803		33	1	22	1		6	63
Bassian Thrush	0.0014							1	1
Collared Sparrowhawk	0.0028				2				2
Crested Shrike-tit	0.0014				1				1
Eastern Yellow Robin	0.0169	1	1		5			7	14
Fan-tailed Cuckoo	0.0085						4	3	7
Golden Whistler	0.0817	1	17	3	19	8	13	10	71
Grey Shrike-thrush	0.0831	1	28		23		1	9	62
Little Corella	0.0606		28	4	9	5	3		49
Long-billed Corella	0.0028			2					2
Mistletoebird	0.0070	1			1	1	1	1	5
Nankeen Kestrel	0.0014				1			1	2
New Holland Honeyeater	0.0789	3	42	2	5			8	60
Olive-backed Oriole	0.0056						3	1	4
Red-browed Finch	0.0493	4			24	1	1	11	41
Rose Robin	0.0014						1		1
Rufous Fantail	0.0028	1			1				2
Rufous Whistler	0.0113					1		9	10
Sacred Kingfisher	0.0141	1			2		4	5	12
Satin Flycatcher	0.0014				1				1
Scarlet Robin	0.0099	1	1		3		2		7
Shining Bronze-Cuckoo	0.0056				1			5	6
Striated Pardalote	0.0239	1		1	5	1	5	4	17
Striated Thornbill	0.0239	1	1	1	9		3	4	19
White-eared Honeyeater	0.0070		1				1	4	6
White-naped Honeyeater	0.0028				2				2
White-throated Treecreeper	0.0085				1			5	6
Yellow Thornbill	0.0056							5	5
Yellow-faced Honeyeater	0.0155		1	1	3			9	14
Total species recorded for LGA		11	11	9	22	7	14	21	
Total number surveys LGA (1998-2015)		53	99	32	289	72	143	21	
Total number surveys 1998-2015									709



Figures 20 a-h. Plot of annual reporting rates (grey points) for bird species identified as urban sensitive species. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.



Figures 20 i-n. Plot of annual reporting rates (grey points) for bird species identified as urban sensitive species. Red line shows the linear trend, with R^2 values indicating the fit of these trends to the points. The higher the R^2 value the better the fit.

Discussion

This report aims to provide a summary and initial overview of the bird communities across the EAGA survey sites. The analysis of data is constrained to those sites included in the project and whilst results have been pooled across each of the contributing LGA's, results should not be extrapolated to these LGAs as a whole. The interactions between birds, remnant vegetation and urban environments are complex, and the aim of this project is not to comprehensively assess the bird populations across the EAGA region, but to sample a subset of sites and provide a baseline for the sampled sites, against which future data can be compared.

Whilst survey participation has been limited to seven volunteers (including the author) the volume of surveys and repeatability at some sites is positive for the ongoing data collection required for this project. If the council employees undertaking the vegetation assessment component of this monitoring also contribute to the bird surveying, then sufficient data should be available to draw more specific conclusions on the bird communities at site scale.

Previous project experience (for example the Melbourne Water Monitoring project managed by BirdLife Australia), suggests that volunteer involvement and community uptake of a project can be slow initially, but once data has been collected and reporting back occurs interest in a project tends to increase – once people realise that their efforts are useful and contribute to something worthwhile they are more likely to participate and continue that participation. Reporting back to participants (and potential participants) is very important. The limiting factor in biodiversity monitoring is the time it takes to collect sufficient data. The time lag of potentially years can lead to drop off in participants. Communication of results and acknowledgement of ongoing participation are important, and how this initial report is communicated to residents and community groups should be carefully considered and a strategy developed to maximise impact.

Urban Bird Communities

Bird community results generally show assemblages expected across urban environments. The dominance of Rainbow Lorikeets, Red Wattlebirds, Noisy Miners and Australian Magpies reflects the findings of other urban studies (Parsons *et al.* 2006; White *et al.* 2009, Catterall *et al.* 2010). All species, along with the increasing Grey Butcherbird, are behaviourally aggressive and medium-to-large body sized, traits strongly associated with dominant urban Australian birds, allowing these species to readily adapt to, or exploit urban environments (Conole and Kirkpatrick 2011). Interestingly, the converse is observed in the Northern Hemisphere, where urban assemblages are dominated by small-bodies species (Garden *et al.* 2006).



The plots of species communities and common species demonstrate how these four species are the most frequently encountered and most abundant species across the EAGA sites. Habitat components contribute to these trends. For example Fitzsimons *et al.* (2003) found that Rainbow Lorikeets appear to prefer well established street scapes, planted with flowering native tree species, and Wood and Recher (2004) found that magpies thrive in highly disturbed

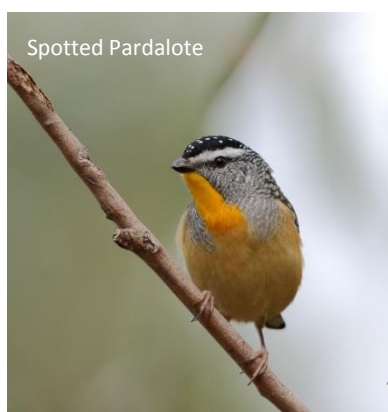
vegetated areas, with little canopy cover. Urban parks, sports ovals and residential lawns provide optimal habitat for this species (Garden *et al.* 2006).

Onsite habitat factors are also important in determining the presence or absence of urban matrix sensitive species (Garden *et al.* 2006). In Australia, many of these are sensitive species small bodied, insectivores that require specific habitat elements, such as leaf litter or fallen timber which provides necessary foraging substrates (for example robin species, Grey Shrike-thrush), rough or decorticated bark (for example Tree-creepers and Shrike-tits). Other species are those that have specialised life history traits, for example cuckoos which parasitise the nest of small insectivorous species (Brooker and Brooker 1989); as host species decline with modified urban habitats, the reproductive success of brood parasites will decline. Many urban sensitive species can be retained in the landscape through retention of appropriate vegetation remnants and the planting and maintenance of required habitats components (Conole and Kirkpatrick 2011). Finding the correct balance between habitat retention, tree and shrub species plantings and community land use requirements is a bit of a juggling act.



The differences in onground habitats may go some way to explain the different trends in bird communities, as well as the starkly different assemblage seen in the Yarra Ranges LGA. The three LGAs that don't show strong linear trends from rare to common species are the three eastern most LGS and perhaps retain more vegetation in the landscape? Yarra Ranges in particular is probably less urbanised than the other municipalities which should contribute to the different species assemblage. Further exploration of habitat, tree cover and "urbanisation" is required and beyond the scope of this report, however some comment on the bird community recorded in the Yarra Ranges is warranted.

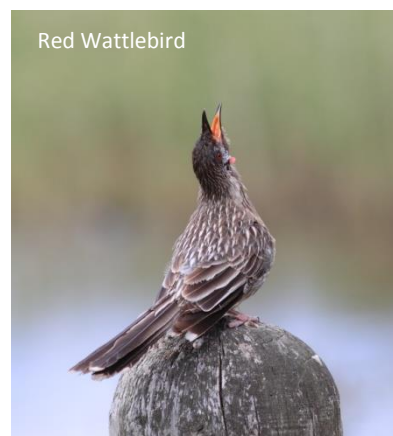
The most wide-spread species across the Yarra Ranges sites are Grey Fantail, Superb Fairy-wrens and Crimson Rosella, the most abundant records are for the Striated Thornbill *Acanthiza lineata*, Red-browed Finch and the introduced Common Starling. Two of these species (Red-browed Finch and Striated Thornbill) have been identified in this project as urban sensitive species, suggesting that the Yarra Ranges sites retain the



necessary habitat elements for these species, which tend to be lost in more urbanised areas. Changes to the bird community over time will be interesting to follow from an academic perspective, particularly if this community begins to support a bird species composition similar to the more urban sites where Noisy Miners, Red Wattlebirds, Rainbow Lorikeets and Magpie dominate. From a biodiversity conservation perspective these changes are detrimental to the retention of smaller, more urban sensitive bird species. It will also be more difficult to determine if the community changes are the result of habitat change or climate change.

In the more urban LGA's, bird community change is less likely to be influenced by habitat changes. It is unlikely that major onground changes will occur, for example loss

of retained remnants or the reestablishment of large tracts of native bushland. This may make it easier to attribute bird community changes to climate effect. A change in community composition is a potential impact of climate change on Australian birds (Chambers *et al.* 2005). Care will need to be taken in drawing conclusions as minor habitat events, such as vegetation planting reaching maturation, or changes to streetscape tree species also have the potential to alter bird communities (Fitzsimons *et al.* 2003). Longterm measurement of habitat condition, also being undertaken as a part of the EAGA Biodiversity Strategy will assist in interpreting these changes.



Red Wattlebird

Implications of Climate Change.

When talking about climate change we generally consider two main components – increasing temperature and changes to rainfall pattern. Increasing temperatures have direct impacts on birds – sustained periods of high temperatures can lead to death and a number of mortality events have occurred that have been conclusively attributed to heat waves (Franklin *et al.* 2014). Indirect effects on birds, shown to be the result of temperature changes include the timing of breeding and the timing and extent of migration (Pulido and Berthold 2012; Schaper *et al.* 2012). There is also growing evidence that changing temperatures is leading to smaller body size in some bird species, however the implications of this are not well understood (Gardner *et al.* 2011, Goodman *et al.* 2012). Increasing temperatures in Australia alpine areas are leading to changes in snow cover. Altitudinal migrants have been arriving a month earlier for the past 30 years, compared to records in the 1970's (Green 2003 in Chamber *et al.* 2005).

The generality that Australia will experience drier times (Suppiah *et al.* 2007) overlooks the seasonal and regional complexity in rainfall patterns (Franklin *et al.* 2014). Direct effects caused by prolonged drought include individual deaths and population declines or influxes of birds to coastal regions. Droughts in the 1970's saw Australian White Ibis move from once heavily populated inland wetlands and waterways to the urban areas, where they are now considered a pest species. Unfortunately, outside of these urban areas White Ibis population continue to decline in survey areas across regional South-eastern Australia. Surveys undertaken in 1983 recorded 22,000 White Ibis. Two years later this count had dropped to 3300. Surveys in 1986 saw an increased count of 24 000 (Kingsford *et al.* 1993, Porter *et al.* 2006). However, between 1998 and 2006 fewer than 3000 individuals were counted across the survey region (Porter *et al.* 2006).



White-plumed Honeyeater

During this period the populations in coastal and particularly urban areas increased (Martin 2012). The other concern with moving wildlife populations to urban areas is the risk of disease (Chambers *et al.* 2005). Indirect effects of changes to the seasonality of rainfall, frequency of droughts and their on-flow effects are harder to quantify.

Australian ecosystems and birds have a long history coping with drought (Robin *et al.* 2009 in Franklin *et al.* 2014), however changing frequencies will shift the

balance in the boom and bust cycle, leaving some species unable to recover after bust periods (Franklin *et al.* 2014). Less direct effects of changing rainfall include changes in vegetation species and structural composition that may be detrimental to bird species life histories (loss of nesting hollows for example), or perhaps lead to changes in the insect communities and subsequently food resources for a component of the avifauna. Low rainfall has been implicated in reducing flowering in key eucalyptus species that supply nectar resources for birds (Mac Nally *et al.* 2009), as well as seasonality of rainfall influencing the timing of flowering events (Keatley *et al.* 2002). These climatic changes, combined with anthropogenic influences have the potential to irrevocably change our avifauna. Promoting resilience among birds by managing these influences may alleviate some of the threat (Chambers *et al.* 2005), and the EAGA project is a positive contribution to this mitigation.

Limited data for the individual climate indicator species has meant that the current analysis presented has been fairly general. Few species show long-term trends, and for those that do it is hard to attribute the changes to climatic factor. As this project progresses and specific data are collected these interactions may be more readily determined. Black-faced Cuckoo-Shrikes may be persisting across the sites, and the results shown here for Flame Robins are consistent with other studies that attribute this decline to climatic changes (Olsen *et al.* 2003 in Chambers *et al.* 2005).

Urban Sensitive Birds

The results of the urban sensitive species are further evidence that Yarra Ranges supports a different avian assemblage, and indication that this municipality may be less urbanised than the others. This LGA recorded more urban specialised species than other LGAs over a much shorter time frame (see Appendix 5), and with substantially less survey effort. Again, these results suggest keeping a close eye on how Yarra Ranges develops and manages its remnant vegetation.

This report is intended to provide a general overview of the bird communities and composition from the initial 6 months on the EAGA Biodiversity Monitoring project. Ongoing surveys and reporting will aid in the management of bird biodiversity over the coming years as well as determine the success of the EAGA project and its resilience building in the face of a changing climate. It must be emphasised that the purpose of setting up monitoring sites is to allow for changes in the bird communities to be detected over time. The project has been designed to look at temporal changes in response to



Yellow Thornbill

climate change and management, not determine which LGA has the best bird community. Sites surveyed differ considerably in size, condition, habitat type and availability and as such should not be compared between each site or LGA, but seen as results independent of one another. Providing results at the LGA scale was undertaken as insufficient data was available at the site level. This also means that each of the EAGA councils can easily find those results pertinent to their council.

Recommendations

The following recommendations are made to assist in this project:

- Develop a strategy to communicate the findings of this and future reports to the general community and volunteers;
- Continue to engage with community members and BirdLife Australia Branches to increase the survey data collected;
- Develop a timeframe and budget for future reporting. It is recommended that a minimum period of 3 years be considered between reporting. This allows for sufficient data collection and a long enough period to determine if trends are occurring. This period however needs to fit with management requirements. Future reporting may become more complex as data is collected, and the need for appropriate statistical data analysis should be budgeted for;
- Follow-up on council staff engagement and the collection of bird data in conjunction with vegetation condition.



Crimson Rosella (juvenile)

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Appendix 1 Complete list of EAGA bird survey sites and additional information

Site Name	Local Government Area	Latitude	Longitude	Area (ha)
Antonio Park	Whitehorse	-37.814400	145.208094	7.21
Bateman Street Bushland	Knox	-37.844102	145.222375	11.53
Beckett Park	Boroondara	-37.810601	145.092280	3.55
Blackburn Lake Sanctuary	Whitehorse	-37.826376	145.162481	26.48
Bungalook Conservation Reserve	Maroondah	-37.829677	145.309072	6.60
Candlebark Walk Reserve	Maroondah	-37.770984	145.267750	11.07
Chandler Park	Boroondara	-37.788855	145.028620	9.54
Damper Creek Reserve	Monash	-37.868424	145.122982	0.90
Damper Creek Reserve	Monash	-37.864547	145.127049	12.43
Fairway Reserve	Monash	-37.890558	145.129225	9.19
Fairway Reserve	Monash	-37.891065	145.122661	5.81
Furness Park	Whitehorse	-37.826596	145.150460	3.42
Glen Iris Park and Wetlands	Stonnington	-37.863218	145.061235	3.08
Heathfield Creek Reserve	Yarra Ranges	-37.808359	145.355543	1.98
Hinkler Reserve	Monash	-37.880788	145.174566	3.67
Koolunga Reserve	Knox	-37.869466	145.294953	5.97
Koonung Creek Reserve	Boroondara	-37.782369	145.093473	32.47
Lakewood Reserve	Knox	-37.879669	145.250045	16.89
Mulgrave Reserve	Monash	-37.921773	145.202170	15.26
Muswell Bend Park	Stonnington	-37.859566	145.062033	0.79
Narr Maen Reserve	Maroondah	-37.777801	145.261035	5.37
Percy Treyvaud Memorial Park	Stonnington	-37.882538	145.080752	6.21
Red Court Reserve	Knox	-37.894558	145.219889	1.71
Ringwood Lake Reserve	Maroondah	-37.812913	145.238361	9.63
Roselyn Reserve	Knox	-37.865284	145.255776	2.56
Ryburne Avenue Reserve	Boroondara	-37.875430	145.072694	1.04
Spadoni's Reserve	Yarra Ranges	-37.682643	145.350605	15.58
UrbanForest	Stonnington	-37.882401	145.072220	3.70
Valley Creek	Monash	-37.880097	145.135301	15.23
Walmer Street Extension	Boroondara	-37.809676	145.010080	0.31
Wandin East Recreational Reserve	Yarra Ranges	-37.814727	145.459839	6.22
Wandinong Sanctuary	Whitehorse	-37.831337	145.152318	1.68
Wards Reserve	Yarra Ranges	-37.876666	145.445663	26.69
Willsmere Park	Boroondara	-37.789046	145.041869	13.78
Wombalano Park	Maroondah	-37.823139	145.253549	7.68
Woods Point Reserve	Yarra Ranges	-37.723301	145.770076	2.09
Yarra River between Punt Road and Caroline St	Stonnington	-37.831787	144.989353	1.01

Appendix 2 Records of Climate Change species across sites (data pooled 1998- 2015). Species in bold are identified climate change species but were not recorded across surveys in 2015.

	EAGA Antonio Park	EAGA Bateman Street Bushland	EAGA Beckett Park	EAGA Blackburn Lake	EAGA Bungalook Conservation Reserve	EAGA Candlebark Reserve	EAGA Chandler Park Central	EAGA Dampier Creek Reserve	EAGA Fairway Reserve	EAGA Furness Park	EAGA Glen Iris Park and Wetlands	EAGA Heathfield Creek Reserve	EAGA Hinkler Reserve	EAGA Koolunga Reserve	EAGA Koonung Creek Reserve	EAGA Lakewood Reserve	EAGA Mulgrave Reserve	EAGA Muswell Bend Park	EAGA Narr-Maen Wetlands Reserve	EAGA Percy Treyvaud Memorial Park	EAGA Redcourt Reserve	EAGA Ringwood Lake	EAGA Roselyn Reserve	EAGA Ryburne Avenue Reserve	EAGA Spadoni's Reserve	EAGA Urban Forest	EAGA Valley Creek Reserve	EAGA Walmer Street Extension	EAGA Wandin East Recreational Reserve	EAGA Wandinong Sanctuary	EAGA Wards Reserve	EAGA Wilsmere Park	EAGA Wombalano Park	EAGA Yarra River Bike Path
Australian Magpie	15	7	5	57		4	2	15	116	29	11	1	38	3	9	78	18	2	1	30	3	14	1	3	11	16	18	1	2	3		10	3	
Black Swan																19																		2
Black-faced Cuckoo-shrike		4		8					11	1	3		1	1	2	10	1					1			3		1			1				
Common Blackbird		6	3	18		1		10	122	19	15	1	6	3	13	74	29	1	1	5	1	11	1	2	9	16	11		1		1	4	1	2
Common Starling							1		71	1	7				11	56	25	1		17		1			3	1	1		2			1		2
Crested Pigeon		1	2					1	9	3	6		1		4	12	1	1	1	30	1	1		1	1	4						6	1	
Dusky Moorhen				18		3	1		2	1	15				4	81	27	1	1			12			7		1							
Eastern Spinebill	2	4	3	12				3	12	3	7	1			3	8			1						1	7	13							
Eastern Yellow Robin		1															4								3		1				4	1		
Fan-tailed Cuckoo				4																					2				1					
Flame Robin									8																		1							
Golden Whistler	4	6		8	1			1	3	1				1	1	10	5					2			6	8	10		1		3			
Grey Butcherbird	6	6	2	26	1	3		10	46	16	6		10	2	3	61	3		1	13	3	5		2	4	6	13	1	1	3		7	3	
Grey Fantail	3	6		17	2			1	8	4	1	1		2	2	31	12					3			11	3	9				5		1	
Horsfield's Bronze-Cuckoo																1	3																	



	EAGA																																	
	EAGA Antonio Park	EAGA Bateman Street Bushland	EAGA Beckett Park	EAGA Blackburn Lake	EAGA Bungalook Conservation Reserve	EAGA Candlebark Reserve	EAGA Chandler Park Central	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Furness Park	EAGA Glen Iris Park and Wetlands	EAGA Heathfield Creek Reserve	EAGA Hinkler Reserve	EAGA Koolunga Reserve	EAGA Koonung Creek Reserve	EAGA Lakewood Reserve	EAGA Mulgrave Reserve	EAGA Muswell Bend Park	EAGA Narr-Maen Wetlands Reserve	EAGA Percy Treyvaud Memorial Park	EAGA Redcourt Reserve	EAGA Ringwood Lake	EAGA Roselyn Reserve	EAGA Ryburne Avenue Reserve	EAGA Spadoni's Reserve	EAGA Urban Forest	EAGA Valley Creek Reserve	EAGA Walmer Street Extension	EAGA Wandin East Recreational Reserve	EAGA Wandinong Sanctuary	EAGA Wards Reserve	EAGA Wilsmere Park	EAGA Wombalano Park	EAGA Yarra River Bike Path
Magpie-lark			2	21		3		7	120	11	13		6		16	65	34	3	1	19		13		3	9	9	7		2			9		1
Masked Lapwing									3		4					43	16		1	6											1			
Pied Butcherbird												1																						
Rufous Whistler											1														8						1			
Shining Bronze-Cuckoo																	1								5									
Welcome Swallow		2	3	8		3	1		26		12		9		14	71	44	1		21		10	1		6	1	4			1		4		2
White-faced Heron				5		1			15		4				1	31	26	1				2			4							1		
Willie Wagtail				8					65		13				10	25	16					2			2	1						1		
Yellow-faced Honeyeater		1															2					1			9		1							
Black-eared Cuckoo																																		
Channel-billed Cuckoo																																		
Eastern Koel																																		
Flame Robin																																		
Lewin’s Honeyeater																																		
Pallid Cuckoo																																		
Swift Parrot																																		



Appendix 3 Records of Urban Sensitive Species across sites (data pooled 1998-2015 data). Species in bold are identified urban sensitive species were not recorded across surveys in 2015.

	EAGA Antonio Park	EAGA Bateman Street Bushland	EAGA Blackburn Lake	EAGA Bungalook Conservation Reserve	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Furness Park	EAGA Glen Iris Park and Wetlands	EAGA Hinkler Reserve	EAGA Koolunga Reserve	EAGA Koonung Creek Reserve	EAGA Lakewood Reserve Central	EAGA Mulgrave Reserve Central	EAGA Narr-Maen Wetlands Reserve	EAGA Percy Treymard Memorial Park	EAGA Ringwood Lake	EAGA Spadoni's Reserve	EAGA Urban Forest	EAGA Valley Reserve	EAGA Wandin East Recreational Reserve	EAGA Wandinong Sanctuary	EAGA Wards Reserve Central	EAGA Wilsmere Park	EAGA Wombalano Park
Australian King-Parrot	1		3		1	1	5					2	1	1		2			1		2	2		1
Australian Reed-Warbler								1				29	18			1	6							
Bassian Thrush																						1		
Collared Sparrowhawk					1	1																		
Crested Shrike-tit													1											
Eastern Yellow Robin		1											4				3		1			4	1	
Fan-tailed Cuckoo			4														2			1				
Golden Whistler	4	6	8	1	1	3	1			1	1	10	5			2	6	8	10	1		3		
Grey Shrike-thrush		5	1			7					1	23	12				7		4			2		
Little Corella			1			5	2		2			28	1	1	5	3			1					
Long-billed Corella																2								
Mistletoebird			1			1		1			1						1							
Nankeen Kestrel						1											1							
New Holland Honeyeater				1							3	42	5			1	8							
Olive-backed Oriole	2		1														1							
Red-browed Finch			1			5		1			3		19				11						1	
Rose Robin							1																	
Rufous Fantail											1								1					
Rufous Whistler								1									8					1		

	EAGA Antonio Park	EAGA Bateman Street Bushland	EAGA Blackburn Lake	EAGA Bungalook Conservation Reserve	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Furness Park	EAGA Glen Iris Park and Wetlands	EAGA Hinkler Reserve	EAGA Koolunga Reserve	EAGA Koonung Creek Reserve	EAGA Lakewood Reserve Central	EAGA Mulgrave Reserve Central	EAGA Narr-Maen Wetlands Reserve	EAGA Percy Treward Memorial Park	EAGA Ringwood Lake	EAGA Spadoni's Reserve	EAGA Urban Forest	EAGA Valley Reserve	EAGA Wandin East Recreational Reserve	EAGA Wandinong Sanctuary	EAGA Wards Reserve Central	EAGA Wilsmere Park	EAGA Wombalano Park
Sacred Kingfisher			4			1							1				5						1	
Satin Flycatcher																			1					
Scarlet Robin		1	2								1								3					
Shining Bronze-Cuckoo													1				5							
Striated Pardalote			5			2		1			1		2			1	4							
Striated Thornbill		1	3	1		8											2		1	1		1	1	
White-eared Honeyeater		1	1																			3		
White-naped Honeyeater						2																		
White-throated Treecreeper																			1			5		
Yellow Thornbill																	5							
Yellow-faced Honeyeater		1														1	9		1					
Brown-headed Honeyeater																								
Dusky Woodswallow																								
Little Eagle																								
Pallid Cuckoo																								
Rufous Fantail																								
Swift Parrot																								
Tree Martin																								
Varied Sitella																								
Whistling Kite																								

Appendix 4 List of all bird species recorded during 2015 surveys across EAGA survey sites.

Birds are in taxonomic order as per the BirdLife Australia Taxonomic Working List (version 1.2).

			Boroondara						Knox				Maroondah				Monash				Stonnington				Whitehorse				Yarra Ranges							
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
Ducks, Geese and Swans																																				
	Freckled Duck	<i>Stictonetta naevosa</i>								2																										
	Black Swan	<i>Cygnus atratus</i>																								4										
	Australian Wood Duck	<i>Chenonetta jubata</i>			2					147				10	72			3		2				16					8	2						
	Pink-eared Duck	<i>Malacorhynchus membranaceus</i>								10																										
	Grey Teal	<i>Anas gracilis</i>								13					2								5	2					2							
	Chestnut Teal	<i>Anas castanea</i>					2			12					6			5	2				11	1					4	22						
	Pacific Black Duck	<i>Anas superciliosa</i>		1	2					72				10	105			2	5				55	4	3	3	2		29	10						
	Hardhead	<i>Aythya australis</i>																					1													
	Blue-billed Duck	<i>Oxyura australis</i>								44																										
Grebes																																				
	Australasian Grebe	<i>Tachybaptus novaehollandiae</i>								1																										
	Hoary-headed Grebe	<i>Poliocephalus poliocephalus</i>								31																										
Pigeons and Doves																																				



			Boroondara						Knox					Maroondah					Monash					Stonnington					Whitehorse				Yarra Ranges			
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
	Rock Dove	<i>Columba livia</i>					3																17	6	3		2									
	Spotted Dove	<i>Streptopelia chinensis</i>	2			1		2		3	27	2				9	8	15	29	12	26	18	17	1	5	5	7	11	7	13	1		7	1		
	Common Bronzewing	<i>Phaps chalcoptera</i>					1		2		1																	7								
	Crested Pigeon	<i>Ocyphaps lophotes</i>	1		8	1		6			8	1					2				1			4	1	22	1									
Frogmouths																																				
	Tawny Frogmouth	<i>Podargus strigoides</i>												1							10								4	11						
Cormorants and Shags																																				
	Little Pied Cormorant	<i>Microcarbo melanoleucos</i>					2							3		2							10				2		1							
	Great Cormorant	<i>Phalacrocorax carbo</i>					3				2																		2							
	Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>									2												4						1	2						
Hérons, Egrets and Bitterns																																				
	White-necked Heron	<i>Ardea pacifica</i>																															1			
	Eastern Great Egret	<i>Ardea alba modesta</i>									1																									
	White-faced Heron	<i>Egretta novaehollandiae</i>									4					1							2	1					1	1			5			
	Nankeen Night-Heron	<i>Nycticorax caledonicus</i>														1							2						2	1						
Ibis and Spoonbills																																				
	Australian White Ibis	<i>Threskiornis moluccus</i>														1					20			2	4		1	1								



			Boroondara							Knox				Maroondah				Monash					Stonnington				Whitehorse				Yarra Ranges					
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
	Straw-necked Ibis	<i>Threskiornis spinicollis</i>								5						1																	6			
Eagles, Kites, Goshawks and Osprey																																				
	Brown Goshawk	<i>Accipiter fasciatus</i>																																1		
	Swamp Harrier	<i>Circus approximans</i>																																1		
Falcons																																				
	Peregrine Falcon	<i>Falco peregrinus</i>														1																				
Crakes, Rails and Swamphens																																				
	Purple Swamphen	<i>Porphyrio porphyrio</i>								68				10		2							9						3							
	Buff-banded Rail	<i>Gallirallus philippensis</i>								4																										
	Dusky Moorhen	<i>Gallinula tenebrosa</i>								23						12					2		35	1					13			1				
	Eurasian Coot	<i>Fulica atra</i>								357				10		26							38						26							
Plovers, Dotterel and Lapwings																																				
	Black-fronted Dotterel	<i>Euseyonis melanops</i>								2																										
	Red-kneed Dotterel	<i>Erythronyx cinctus</i>								1																										
	Masked Lapwing	<i>Vanellus miles</i>								10															2											
Snipe,																																				



			Boroondara						Knox					Maroondah					Monash					Stonnington					Whitehorse					Yarra Ranges				
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wiismere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve		
Sandpipers, Godwits, Curlew, Stints and Phalaropes																																						
	Latham's Snipe	<i>Gallinago hardwickii</i>								1																												
Gulls, Terns and Noddies																																						
	Silver Gull	<i>Chroicocephalus novaehollandiae</i>																					5		6		1											
Cockatoos and Corellas																																						
	Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>							3		3											2							7									
	Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>																													2							
	Galah	<i>Eolophus roseicapillus</i>			8						6				10		5	2		2			3							2	2				2			
	Long-billed Corella	<i>Cacatua tenuirostris</i>														9																						
	Little Corella	<i>Cacatua sanguinea</i>									15					7				10											16							
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>					7		7					3			2							4			3						4			1		
Parrots, Lorikeets and Rosellas																																						
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	12	40	4	22	9	12	1	3	52	14	2		10		34	4	68	32	25	7	36	29	7	55	9	5	43	19	70	8	1					
	Musk Lorikeet	<i>Glossopsitta concinna</i>	4		4	1		24			7	19							24	6	19		15			47	8		2		21							



			Boroondara						Knox					Maroondah					Monash					Stonnington					Whitehorse				Yarra Ranges			
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
	Australian King-Parrot	<i>Alisterus scapularis</i>														2	1	1										2		8					5	
	Crimson Rosella	<i>Platycercus elegans</i>		1			2	4	6	26	4			4		1	6	3		3		3						2					7	1	1	13
	Eastern Rosella	<i>Platycercus eximius</i>					6			3	5	2	4			2		6	5	8	3	2				5			2	1				4		
	Red-rumped Parrot	<i>Psephotus haematonotus</i>		2	4		4																2													
Cuckoos																																				
	Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>																												1				1		
Tree Kingfishers																																				
	Laughing Kookaburra	<i>Dacelo novaeguineae</i>		1			3		1							2		2		1	1							1	3	2			4	5	1	
	Sacred Kingfisher	<i>Todiramphus sanctus</i>																											1				1			
Treecreepers																																				
	White-throated Treecreeper	<i>Cormobates leucophaea</i>											3																						10	
Fairy-wrens, Emu-wrens and Grasswrens																																				
	Superb Fairy-wren	<i>Malurus cyaneus</i>		2			1							15							24		42							21			5	9		12
	White-browed Scrubwren	<i>Sericornis frontalis</i>					1			7						5	6	1	3		18	10	18			6		5	9						6	
Thornbills and Gerygones																																				
	Striated Thornbill	<i>Acanthiza lineata</i>						3					10																				4	20	20	

			Boroondara						Knox					Maroondah				Monash					Stonnington					Whitehorse				Yarra Ranges				
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	Yellow Thornbill	<i>Acanthiza nana</i>						4																									2			
	Brown Thornbill	<i>Acanthiza pusilla</i>			9	3		3	8	14	20					21	29	3	11		13	10	9	1		7			12	41	8		6	3		6
Pardalotes																																				
	Spotted Pardalote	<i>Pardalotus punctatus</i>		2	9			3		4	4						3	4	4			6	5			4				7			3		1	7
	Striated Pardalote	<i>Pardalotus striatus</i>			1																		1													
Honeyeaters and Chats																																				
	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>			2				2		2			3			2					4	13						3	4			1			
	Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>																			2												4			
	White-eared Honeyeater	<i>Lichenostomus leucotis</i>																											1						12	
	White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>									10										18		25				15			2			4			
	Noisy Miner	<i>Manorina melanoccephala</i>	15	16	18	15	2	7	3		50	35	10		10		34		43	56	60	7	25	18	7	71	15		81	19	50	8				
	Little Wattlebird	<i>Anthochaera chrysoptera</i>									3								1				2				2	1								
	Red Wattlebird	<i>Anthochaera carunculata</i>	2	1	2	4	1	2	17	8	109	13		4		9	18	35	76		36	47	39	5	3	36	13	62	10	28		3	3	7		
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>									13			1																						
Cuckoo-shrikes and Trillers																																				
	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>							2	4													1							1						

			Boroondara						Knox					Maroondah					Monash					Stonnington					Whitehorse				Yarra Ranges			
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
Whistlers, Shrike-thrushes and allies																																				
	Golden Whistler	<i>Pachycephala pectoralis</i>						2		1				5			1			2			1						5	1					2	7
	Rufous Whistler	<i>Pachycephala rufiventris</i>																															1		1	
	Grey Shrike-thrush	<i>Colluricincla harmonica</i>						2													5														5	
Orioles and Figbirds																																				
	Olive-backed Oriole	<i>Oriolus sagittatus</i>																											2							
Woodswallows Currawongs Butcherbirds and Magpie																																				
	Grey Butcherbird	<i>Cracticus torquatus</i>		1		2	1	3	2	1	11	4		1			3	3	5		7	2	3	2		3	2		9	2	8	1			2	
	Pied Butcherbird	<i>Cracticus nigrogularis</i>																		1																
	Australian Magpie	<i>Cracticus tibicen</i>	11	5	3	7	1	7	6	2	52	8	1	2	5		28	9	18	21	15	19	18	3	3	13	17		50	9	32	4	2	6	3	
	Pied Currawong	<i>Strepera graculina</i>	6		1	4			1		2				3		11	6	6	5	24		11			3	2		21	4	10		1			
	Grey Currawong	<i>Strepera versicolor</i>	1						1					6						2																
Fantails																																				
	Grey Fantail	<i>Rhipidura fuliginosa</i>							1	1	10			9			16					7	2						6	9			6	4		9
	Willie Wagtail	<i>Rhipidura leucophrys</i>					1				1												9			1										

			Boroondara							Knox					Maroondah					Monash					Stonnington					Whitehorse				Yarra Ranges			
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve	
Crows and Ravens			2		1	5		2			12			5	5		14	2	3	13	15	10	22	12	2	11	13	7	15	3	20		1	4	3	1	
Monarch and Flycatchers																																					
	Magpie-lark	Grallina cyanoleuca				5		29			19				4		3		4	6		5	2	13	3	3	4	1		3	12				4		
Australian Robins																																					
	Scarlet Robin	Petroica multicolor											2																								
	Rose Robin	Petroica rosea											1																								
	Eastern Yellow Robin	Eopsaltria australis																			4														7		
Reed-Warblers																																					
	Australian Reed-Warbler	Acrocephalus australis									1																										
Grassbirds																																					
	Little Grassbird	Megalurus gramineus									4																										
True Babblers																																					
	Silvereye	Zosterops lateralis			4			10			15						25												7				9	2			
Swallows and Martins																																					
	Welcome Swallow	Hirundo neoxena	4	2	8			3			94		1		10		15				2	1		11	1	10		4					5				
Thrushes																																					
	Bassian Thrush	Zoothera lunulata																																	1		

			Boroondara						Knox					Maroondah					Monash					Stonnington					Whitehorse				Yarra Ranges			
Family	Common Name	Scientific name	EAGA Beckett Park	EAGA Chandler Park	EAGA Koonung Creek Reserve	EAGA Ryburne Avenue Reserve	EAGA Walmer Street Extension	EAGA Wilsmere Park	EAGA Bateman Street Bushland Reserve	EAGA Koolunga Reserve	EAGA Lakewood Reserve	EAGA Redcourt Reserve	EAGA Roselyn Reserve	EAGA Bungalook Conservation Reserve	EAGA Candlebark Walk Reserve	EAGA Nar-Maen Reserve	EAGA Ringwood Lake	EAGA Wombalano Park	EAGA Damper Creek Reserve	EAGA Fairway Reserve	EAGA Hinkler Reserve	EAGA Mulgrave Reserve	EAGA Valley Creek Reserve	EAGA Glen Iris Park and Wetlands	EAGA Muswell Bend Park	EAGA Percy Treyvaud Memorial Park	EAGA Urban Forest	EAGA Yarra River Bike Path	EAGA Antonio Park	EAGA Blackburn Lake	EAGA Furness Park	EAGA Wandinong Sanctuary	EAGA Heathfield Creek Reserve	EAGA Spadoni's Reserve	EAGA Wandin East Recreational Reserve	EAGA Wards Reserve
	Common Blackbird	<i>Turdus merula</i>			2		3	2	5	26	1	2	2			3	2	4	21		17	1	22	1		18	2			2		3	4	10	1	
	Song Thrush	<i>Turdus philomelos</i>								1																										
Starlings																																				
	Common Starling	<i>Sturnus vulgaris</i>								18											25		16	7	2		11							70		
	Common Myna	<i>Sturnus tristis</i>			1				11	51		2				2	3	19					7		3	13	16			7		1	5	12		
Sunbirds and Flowerpeckers																																				
	Mistletoebird	<i>Dicaeum hirundinaceum</i>																					1													
Weaver Finches																																				
	Red-browed Finch	<i>Neochmia temporalis</i>											18																				22			
	House Sparrow	<i>Passer domesticus</i>																														2				

Appendix 5 Survey effort across years within LGAs.

Row Labels	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Boroondara		2	15					1		2		3	3	1	5	5		16	
Knox		5	7	4	3		1	4	3	9	1	1	3	5		14	20	18	1
Maroondah					1				1	1	1			1	1	3	9	12	2
Monash	16	40	30	34	18	9	4	2	2	3	2	6	16	16	14	11	24	42	
Stonnington				1						1		3	11	8	5	7	3	33	
Whitehorse		1		1		2	33	7	2	5	8	14	4	6	6	7	13	33	1
Yarra Ranges														2	6	2	1	9	1
Grand Total	16	48	52	40	22	11	38	14	8	21	12	27	37	39	37	49	70	163	5