# COMMUNITIES LISTENING FOR NATURE

Citizen science in Mount Worth State Park 2016-2019



Superb Fairy-wren. Photo: Andrew Haysom

## A REPORT ON A COMMUNITY PARTNERSHIP IN ECO-ACOUSTIC MONITORING IN MOUNT WORTH STATE PARK, VICTORIA

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#### **Victorian National Parks Association**

The Victorian National Parks Association (VNPA) helps to shape the agenda for creating and managing national parks, conservation reserves and other important natural areas across land and sea. We work with all levels of government, the scientific community and the general community to achieve long term, best practice environmental outcomes. The VNPA is also Victoria's largest bush walking club and provides a range of information, education and activity programs to encourage Victorians to get active for nature.

#### NatureWatch

NatureWatch is a citizen science program which engages the community in collecting scientific data on Victorian native plants and animals. The program builds links between community members, scientists and land managers to develop scientific, practical projects that contribute to a better understanding of species and ecosystems, and contributes to improved management of natural areas.

#### **Project Partners**





#### **Museums Victoria**

Museums Victoria has been trusted with the collection and curation of Victoria's natural history for over 160 years and serves as a key international research institute and experts in data archiving and long-term data protection. Responding to changing intellectual issues, studying subjects of relevance to the community, providing training and professional development, and working closely with schools, communities, and online visitors, Museums Victoria works to disseminate our collective knowledge through online resource s and image, audio and video databases.

#### **Mount Worth & District Landcare**

The group has been operating with private land managers for over 10 years, largely focussed on revegetating the degraded landscape, supporting the retention of remnant vegetation and providing connections across the landscape to the State Park. Much of the work has sought to help species under threat.



#### Friends of Mount Worth State Park

The Friends have been working in the Park since its declaration in the late 1970's to improve the landscape values of the Park, improve access for the public to enjoy and understand the environment, and promote appreciation of the Park.

#### Acknowledgements

Victorian National Parks Association: Matt Ruchel, Emily Clough, Heath Rickard Mount Worth & District Landcare and Friends of Mount Worth State Park: Paul Strickland, Merrin Butler Private Landholders: Merrin Butler & Paul Strickland, Lyn Seymour, Rosemary Kennedy, Paul Stewart & Ann Butler, Mark Pilkington, Margaret & Cameron McDonald, Burkhardt Klinger Parks Victoria: Craig Campbell

VNPA acknowledges the Boon Wurrung, Bunurong and Gunai/Kurnai people who identify Mount Worth State Park as their Traditional Country.

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Helen Macpherson Smith Trust

### Summary

In 2016 and 2017, the Victorian National Parks Association (VNPA) partnered with Museums Victoria and local groups Friends of Mount Worth State Park and Mount Worth District Landcare Network to monitor bird populations in Mount Worth State Park and nearby private properties.

- 10,126 hours of recordings were collected across 17 sites.
- 40 bird species were identified.
- Listed threatened species, Powerful Owls, were at two sites.
- Volunteer contributed 218 days of fieldwork (approximately 1417 hours), 64 hours of project planning and numerous hours of equipment management.

Monitoring bird populations is an effective way to evaluate local biodiversity, and corresponding habitat condition. However, it is time-consuming to both collect and analyse bird sightings or bird call data. The study of eco-acoustics allows for the collection of bird call data across large areas of land and over an extended period with a minimal number of people in the field.

The groups provided local expertise and collected the bird song data with the support of VNPA while experts at Museums Victoria analysed the data. Together this partnership delivered an assessment of the bird assemblages in different age categories of native vegetation regeneration on private land around the park and within the park itself.

Information from this project will help the local community and land managers, Parks Victoria, with their land management planning including the management of threats and the protection of threatened species. In addition, this project has been an excellent way to increase expertise in local bird species and their habitat requirements as well as increasing awareness of the value of protected areas in preserving local biodiversity.

This project has provided Museums Victoria with a new bird call data set to add to their online collections and to enhance their bird call recognition software. This will improve their ability to identify quickly and accurately assess bird populations in Victoria.

Bird species detected					
Australian King Parrot	Gang-gang Cockatoo	Rose Robin			
Australian Magpie	Golden Whistler	Southern Boobook			
Australian Owlet-nightjar	Grey Butcherbird	Spotted Pardalote			
Australian Raven	Grey Fantail	Striated Pardalote			
Bassian Thrush	Grey Shrike-thrush	Sulphur-crested Cockatoo			
Brown Thornbill	Laughing Kookaburra	Superb Fairy-wren			
Brush Bronzewing	Magpie-lark	Tawny Frogmouth			
Common Blackbird*	Masked Lapwing	<i>Tyto</i> species			
Corella species	Noisy miner	White-browed Scrubwren			
Crimson Rosella	Olive Whistler	White-throated Treecreeper			
Eastern Whipbird	Pied Currawong	Yellow-faced Honeyeater			
Eastern Yellow Robin	Pilot Bird	Yellow-tailed Black-cockatoo			
Fan-tailed Cuckoo	Powerful Owl	* Introduced species			
Galah	Red Wattlebird				

This research was conducted under DELWP research permit #10007964.

## 1. Introduction

#### **Communities Listening for Nature**

Communities Listening for Nature is an exciting citizen science project, run by the Victorian National Parks Association in partnership with Museums Victoria, and local community groups and land managers. The program involves collaborative research design and implementation utilising new acoustic technology to monitor native birds in Victoria.

The aim of Communities Listening for Nature is to engage, train and equip community groups and volunteers in Victoria as citizen scientists who can detect, record and study Victorian birds, including some of the State's threatened species. This program supports local community expertise in bird identification and habitat use, providing important knowledge of Victorian bird species to assist with active management and conservation planning.

Data collected by citizen scientists will contribute to answering the project research questions, be added to the Victorian Biodiversity Atlas, and contribute to Museums Victoria's curated sound reference library of Victorian birds. Scientists, land managers, conservation groups and the general public worldwide can use this reference library to investigate Australia's unique bird life.

#### The study of bioacoustics

Bioacoustics combines acoustic and biological principles to record and analyse sounds in nature. It goes beyond just species identification and can investigate how an animal relates to their environment.

Recording devices, such as Song Meters, are easy to install in the field to record bird sounds. They can be programmed to focus on recording at certain times of the day and the frequency of recording. Recordings can also be set up simultaneously at multiple locations and rotated regularly to new locations, to maximise data collection. This survey method can provide data on the presence of secretive species or species that vocalise infrequently which have a greater probability of being missed during human-based surveys.

The recordings collected from the field are analysed using specialised software that interprets bioacoustic sound frequency as visual displays called spectrograms. Spectrograms essentially graph the sound and can be annotated by bird sound identification experts to identify the species. They can also be run through auto-detection software that can extract patterns for specific species against recognisers in models developed from previous identifications. However, whilst acoustic monitoring can provide clear evidence of the presence of particular species, and presence within different habitats, it cannot give comprehensive information about how many individuals there are in an area.

Acoustic monitoring also allows the assessment of the soundscape of a site, a reliable ecological monitoring tool for biodiversity (Fuller et al. 2015) that is an indicator of the natural calling activity of species across long periods of time that may not be possible in time-restricted, human-based surveys. One way to summarise soundscape data is to calculate an Acoustic Complexity Index (ACI) at each site (Pieretti et al. 2011). This calculation measures the complexity of bird sounds in a soundscape to indicate both singing activity and the diversity of birds that are present. Higher ACI values indicating more singing activity and greater bird diversity. ACI values can then be compared across sites to help understand how different sites compare with

one another or are associated with different characteristics (e.g., do sites differ in their ACI in different Ecological Vegetation Classes).

Beyond drawing out ecological information from sound recordings, audio clips of local soundscapes and species are a great educational resource to present to the community. In this project, each recording is independently analysed by experts at Museums Victoria, archived digitally and stored in their collections into perpetuity. This makes them permanent, verifiable evidence of the presence of bird species at specific locations, and a valuable tool in monitoring threatened and other species.



#### Monitoring in Mount Worth State Park

Approximately 125 km south east of Melbourne, Mount Worth State Park is in the heart of the western Strzelecki Ranges, in the Gippsland region of Victoria. Historically, the area was covered in tall, wet forest communities before being cleared by early explorers for agriculture. This history of land clearing, coupled with large bushfires, had led to an open landscape with fertile soils suited to productive agriculture and dairy production. As smaller agricultural blocks exhausted their commercial value, trends have turned to restoring native bushland to support adjacent productive land and towards increased interest in rural lifestyle properties.

Today, Mount Worth State Park remains one of the most intact areas of forests in the Western Strzelecki Ranges. It is home to a diverse community of over 100 bird species that can tolerate altered habitats. It is home to many species that are declining elsewhere across the ranges such as Pilotbirds, Rose Robins, the Superb Lyrebird, Brush Bronzewings, Yellow-tailed Black Cockatoos and the Powerful Owl. Threatened species in the park include:

- Powerful Owl (Ninox strenua)
- Hardhead (Aythya australis)
- Diamond Firetail (Stagonopleura guttate)
- White-throated Needletail (Hirundapus caudacutus)

#### **Project Design**

This project was developed in conjunction with project partners in April 2016. Song Meters were active in the field between 9 August to 20 October in 2016 and from 1 February to 22 August 2017. During these times song meters were moved to new locations every three weeks, across five sites each. With each move, the data was collected and delivered to Museums Victoria for analysis.

#### Project Aims – Research

- To investigate the effect of habitat restoration efforts in the park and on private land in the region are having on birds in terms of species presence/absence and site acoustic complexity index.
- 2. To investigate changes in bird species in four different ages of habitat restoration revegetation.
- 3. To detect the presence of any threatened bird species and confirm existing records.
- 4. To provide an updated and reliable species list for the park.

#### **Project Aims – Community Outreach**

- 5. Increased understanding, knowledge and interest in the local community of what species are here to the participating members and wider community. Species lists and sample bird calls will be helpful.
- 6. Building awareness of what habitats within the study area are providing for birds.
- 7. To provide private landholders who participated in this research with soundscapes for their property and to use soundscapes from the region in community education initiatives.

## 2. Methods

#### Song Meter Methodology

Communities Listening for Nature uses 'Song Meter SM4' devices from Wildlife Acoustics. Each Song Meter contains two built-in microphones for multidirectional recording and two 64 GB SD cards, all contained within a weatherproof protective case.

Field recording occurred from 6<sup>th</sup> August to 25<sup>th</sup> December 2016. Song Meters were in operation for three weeks at each site. They were secured on a tree trunk at the centre of each site (Figure 1). At each site, volunteers located the centre of the site (using GPS coordinates) and used the nearest suitable tree to set up the Song Meters. Song Meters were fixed to a tree trunk at approximately ear height (about 150 cm) above the ground with an elastic strap and secured with a cable-lock to prevent damage and theft (Figure 1). Recording began on the day they were set-up and stopped either when the SD cards were full or when the Song Meter was retrieved.

To increase the chances of detecting all species present while collecting a manageable amount of data, the Song Meters were programmed with a recording schedule of:

- a) Start an hour before sunset, recording for three hours
- b) Recording for 10 minutes, each hour, overnight
- c) Start an hour before sunrise, recording for 2 hours
- d) Recording for 10 minutes, each hour throughout the day
- e) Recording stops when memory cards are full (approximately 30 days).



Figure 1: Song Meter SM4 acoustic recording device. Photo: Sera Blair

#### Site Selection:

Study sites were selected within Mount Worth State Park and on surrounding private land (Figure 2) to include a series of control sites and revegetation sites exhibiting varying stages of the revegetation process (Table 1). Multiple sites within each of these categories were selected to ensure replication within each revegetation category and to prevent site-specific factors (e.g., the presence of certain species of trees or shrubs) influencing the results.

Revegetation categories:

- Control (CO) = property has not received any revegetation efforts, may be a mix of mature or young
  vegetation, native and non-native species or cleared land.
- Early Age Revegetation (ER) = property has revegetation 1 to 5 years old.
- Medium Age Revegetation (MR) = property has revegetation 5-10 years old.
- Older Age Revegetation (OR) = property has revegetation 11 years old and older.

Sites were selected across the two main Ecological Vegetation Classes (EVC) of the park including Damp Forest (EVC 29, least concern conservation status), and Wet Forest (EVC 30, least concern conservation status). Sites were, at a minimum, separated by 1 km to ensure they represented independent sites in terms of vegetation as well as to ensure independence in the birds detected in recordings.

#### Land Tenure:

- Private property revegetation by individual landowners, support through Landcare network.
- Mount Worth State Park revegetation planned and implemented by Parks Victoria.



Figure 2: Site locations in Mount Worth State Park and surrounding private properties.

#### Data analysis

Acoustic field recordings were sent to Museums Victoria for analysis where species-specific recognisers were generated for threatened bird species previously recorded in Mount Worth State Park. Recognisers are a type of model created based on available, pre-existing high quality vocalisations ('template vocalisations') for a species. Once created, recognisers were used in an automated process to scan the acoustic field recordings collected by Song Meters to detect vocalisations ('candidate vocalisations') that matched the template vocalisations. Candidate vocalisations were then manually checked to verify species presence as false positive detections are common with recognisers. Incidental bird species detected while validating the output from the recognisers were also recorded.

Further analysis to produce site-level lists and detect additional species will be possible in the future, but will require longer processing and evaluation time. Therefore, results from this study serve as a preliminary list of species detected in the surveys.

Table 1. Sites surveyed in this study, including the year of survey, the tenure of the land, the category of revegetation (Control = property has not received any revegetation efforts, Early Age = revegetation 1-5 years old), Medium Age = revegetation 5-10 years old, and Older Age = revegetation 11+ years old) and the Ecological Vegetation Class (DELWP 2018).

Site	Survey Year	Land Tenure	<b>Revegetation Category</b>	<b>Ecological Vegetation Class</b>
MWCO01	2016	State Park	Control	Wet Forest
SECO02	2016	Private	Control	Damp Forest
STOR01	2016	Private	Older Age	Damp Forest
MWMR01^	2016	State Park	Medium Age	Wet Forest
KEMR02	2016	Private	Medium Age	Wet Forest
BUOR01	2017	Private	Older Age	Damp Forest
BUNR02^^	2017	Private	Early Age	Damp Forest
BUMR03	2017	Private	Medium Age	Damp Forest
MCC001*	2017	Private	Control	Damp Forest
MWOR03**	2017	Private	Older Age	Damp Forest
SEER02	2017	Private	Early Age	Damp Forest
MWCO02	2017	State Park	Control	Wet Forest
MWMR02	2017	State Park	Medium Age	Damp Forest
STOR02	2017	Private	Older Age	Damp Forest
PICO01	2016	Private	Control	Wet Forest
PICO02	2016	Private	Control	Wet Forest
PIER01	2016	Private	Early Age	Wet Forest

^ The EVC classification is no longer accurate for this site. It could be considered Damp Forest now.
^^ This site was misnamed as "NR" for "New Revegetation", it should have been BUER02 to be consistent with the 'Early Revegetation' category name.

\* Property is sheep paddock with one significant paddock tree as the focal spot.

\*\* On private land, mislabelled as MW. Revegetation is primarily Mountain Ash (Eucalyptus regnans).

Figures 3 and 4: Site STOR02, private land, older age revegetation in Damp Forest EVC.



Figure 5 and 6: Site MCCO01, control site in Damp Forest EVC.



## 3. Results

#### Acoustic recordings

Song meters were deployed on private land and within Mount Worth State Park between 9 August 2016 and 22 September 2017. Altogether, 29,059 usable acoustic field recordings were collected from 17 sites over 318 days of monitoring. Over all sites, 10,126 hours of recordings was collected and between 543 and 3202 recordings were made at each site over multiple deployments with an average of 595.7 hours per site. The total volume of data collected was 3.08 TB.

Despite this large volume of acoustic data collection, only 2% (667 files) of files were corrupted and considered unusable. These issues are likely due to exhausted batteries at the end of a deployment.

#### **Bird species recorded**

Of the four threatened species targeted for detection in this study, only one species, Powerful Owl, was detected with recognisers. Powerful Owl is listed a vulnerable on the Advisory List of Threatened Vertebrates, by the Victorian Government (DSE 2013). An additional 39 bird species were documented across all sites in Mount Worth State Park (Table 2). Of these 40 species, one, Common Blackbird, is introduced.

#### Comparison of bird diversity and land tenure

Research sites were not equally distributed between private and public land tenures with 13 sites on private land and 4 within Mount Worth State Park. Twenty-seven bird species were recorded on private land sites and 16 species with the park (Table 2). Therefore approximately 20% of sites (4 park sites) detected 40% of the bird species. Surprisingly, only two species were recorded on both site categories: Red Wattlebird and unidentified *Tyto* species.

Table 2: Bird species identified by acoustic recordings by land tenure. Numbers represent independent detections but do not represent the number of individuals detected.

Species	Private Land	State Park
Australian King-parrot	1	
Australian Magpie	3	
Australian Owlet-nightjar		3
Australian Raven	1	
Bassian Thrush		1
Brown Thornbill		2
Brush Bronzewing	1	
*Common Blackbird	2	
Corella species	2	
Crimson Rosella	6	
Eastern Whipbird	1	
Eastern Yellow Robin		3
Fan-tailed Cuckoo		2
Galah	2	
Gang-gang Cockatoo	4	
Golden Whistler	4	
Grey Butcherbird	2	
Grey Fantail	2	
Grey Shrike-thrush		1

Species	Private Land	State Park
Laughing Kookaburra		1
Magpie-lark	2	
Masked Lapwing	3	
Noisy Miner	1	
Olive Whistler	3	
Pied Currawong		1
Pilotbird		1
Powerful Owl		4
Red Wattlebird	1	1
Rose Robin	2	
Southern Boobook		3
Spotted Pardalote	2	
Striated Pardalote	1	
Sulphur-crested Cockatoo		1
Superb Fairy-wren	2	
Tawny Frogmouth	2	
Tyto species	8	2
White-browed Scrubwren	1	
White-throated Treecreeper		1
Yellow-faced Honeyeater	2	
Yellow-tailed Black-cockatoo	1	1
Total verified detections (89)	61	28

#### **Threatened Species**

In this study we only detected one threatened species, the Powerful Owl, which are listed as vulnerable in Victoria (DSE 2013). One Powerful Owl recording was collected from a control site at the edge of Mount Worth State Park, while the other was on private land in an area of old Mountain Ash (*Eucalyptus regnans*) regrowth forest. Unidentified owl species within the *Tyto* genus were recorded in control, medium revegetation and long revegetation categories. These could include threatened species such as: Masked Owl (endangered), Sooty Owl (vulnerable) or Barn Owl (not listed) (DSE 2013).





#### Comparison of bird diversity and revegetation age

Of the forty birds detected in this study, control sites recorded the most with twenty seven species. This was followed by medium age revegetation with thirteen species, older age revegetation with eleven species and early age revegetation with just seven species detected (Table 3). Only unidentified *Tyto* owl species were detected across all revegetation categories.

Species detected on early revegetation sites were largely species that travel larger distances such as parrots and owls. The smaller species detected, Striated Pardalote and Superb Fairy-wren, are widely distributed, utilising a diverse range of habitats. Superb Fairy-wrens prefer dense grass and shrubby undergrowth allowing them to utilise highly modified landscapes (Morecombe 2014).

Medium age revegetation sites presented a wider variety of bird species, including some like Australian Magpie, Golden Whistler, Grey Fantail and Grey Butcherbird who are commonly found on partly cleared farmland, open woodlands and eucalypt forests (Morecombe 2014). They require more trees in their landscape for hunting (small prey on the ground, raiding other nests, insects and lerps) and nesting (Morcombe 2014).

Sites with older revegetation were the only sites visited by Brush Bronzewing, Australian Raven and Red Wattlebird. Red Wattlebirds are common in woodlands and forests whereas Australian Ravens usually prefer more open country (Morcombe 2014). Brush Bronzewings are uncommon and prefer undisturbed habitat dominated by dense ground cover and mid-size trees (Morcombe 2014).



Grey Fan-tail Photo: Andrew Haysom

Table 3: The distribution of incidental bird call detections by age of revegetation. Control (CO) = property has not received any revegetation efforts, Early Age (ER) (revegetation 1-5 years old), Medium Age (MR) (revegetation 5-10 years old), and Older Age (OR) (revegetation 11+ years old). Lack of detections at individual sites does not indicate a lack of species within these sites just that our opportunistic detection method for species other than our target species did not result in detections at that site.

Species	Control	Early	Medium	Older
Australian King-parrot		✓		
Australian Magpie	✓		✓	$\checkmark$
Australian Owlet-nightjar	✓			
Australian Raven				$\checkmark$
Bassian Thrush	✓			
Brown Thornbill	✓		✓	
Brush Bronzewing				$\checkmark$
Common Blackbird*	✓		✓	
Corella sp.			✓	
Crimson Rosella	✓			
Eastern Whipbird	✓			
Eastern Yellow Robin	✓			
Fan-tailed Cuckoo	✓			
Galah	✓	✓		
Gang-gang Cockatoo		$\checkmark$		$\checkmark$
Golden Whistler			✓	✓
Grey Butcherbird	✓		✓	
Grey Fantail	✓		✓	
Grey Shrike-thrush	✓			
Laughing Kookaburra	✓			
Magpie-lark	✓			
Masked Lapwing		✓	✓	✓
Noisy Miner			✓	
Olive Whistler	✓			
Pied Currawong	✓			
Pilotbird	✓			
Powerful Owl	✓			$\checkmark$
Red Wattlebird				✓
Rose Robin	✓			
Southern Boobook	✓			
Spotted Pardalote			✓	$\checkmark$
Striated Pardalote		$\checkmark$		
Sulphur-crested Cockatoo	✓			
Superb Fairy-wren		$\checkmark$	✓	
Tawny Frogmouth			✓	
<i>Tyto</i> species	✓	$\checkmark$	✓	$\checkmark$
White-browed Scrubwren	$\checkmark$			
White-throated Treecreeper	$\checkmark$			
Yellow-faced Honeyeater	✓			
Yellow-tailed Black-cockatoo	✓			✓
Total number of species	27	7	13	11

\*introduced species

#### Acoustic Complexity Index Comparison between revegetation categories

Overall, Acoustic Complexity Index (ACI) was greatest in the Early Age revegetation sites when compared to Medium and Older Age and Control sites (Figure 8). This suggests greater species richness in Early Age revegetation as the forest initially increases in biomass and structural complexity, with a gradual decline as the forest matures. This pattern is similar to what is observed in naturally regenerating habitats (e.g., after fire or clearing) - as the forest starts to regenerate, vegetation quickly fills in with a dense understory, providing initial habitat for many early colonising and woodland species. As the forest begins to mature, the vegetation community gradually shifts and the initial colonising species often move on, leaving woodland species to occupy the maturing forest.

Figure 8. Overall Acoustic Complexity Index comparison across revegetation categories (Early Age, Medium Age, Older Age) when compared to control vegetation (Control).



#### Seasonal variation in Acoustic Complexity Index

Across seasons, ACI varied both within and across revegetation categories (Figure 9). The greatest difference among revegetation categories was in spring, when Early Age sites had the greatest ACI. In contrast, Medium Age sites were greatest in summer and autumn. Older Age had the greatest ACI in spring, whereas autumn was when Control sites had the greatest ACI. These patterns suggest different vocal species may be using each of these revegetated habitats in different ways throughout the year, suggesting a variety of revegetation category forests within the landscape may provide seasonal habitat choices for animals.



Figure 9. Comparison of Acoustic Complexity Index across revegetation categories and seasons.

#### Land tenure variation in Acoustic Complexity Index

ACI values were comparable between private land sites than within Mount Worth State Park sites. While the number of private land sites were much greater (n = 13) than sites within the park (n = 4; Figure 10), revegetation sites within the park may also represent areas that were revegetated with a greater diversity of native flora, as encouraged by Landcare groups, which may increase their species richness and value across the region. However, the small sample size of sites within the park, and the close proximity to each other, makes it difficult to compare acoustic complexity between different land tenures with confidence.

Figure 10. Comparison of Acoustic Complexity Index between private land (yellow) and Mount Worth State Park sites (blue).



## 4. Discussion

This Communities Listening for Nature study provides evidence that revegetation efforts in parks and on private land are successful in providing habitat for a wide range of bird species around Mount Worth State Park. Early age revegetation efforts, 1-5 years old, presented the most bird detections on revegetation sites. They tended to include larger birds like parrots and owls that utilise a larger home range and smaller colonising species such as Striated Pardalote and Superb Fairy-wrens who persist well in highly modified landscapes and require less trees. Medium age revegetation, 5-10 years, revealed bird species that require more tree structure for nesting and hunting perches. Older age revegetation, 11+ years, had more species that preferred undisturbed habitat, more advanced ground cover and larger trees. By investigating the different ages of revegetation, landholders and park managers can now understand the potential species they can expect with more revegetation and by letting it age, helping them to better plan revegetation efforts across the landscape.

This project detected 39 verified recordings of native bird species (and 1 introduced species), approximately 41% of species listed on the Global Biodiversity Index Facility. While partial, this provides an updated species list for the Mount Worth State Park and some surrounding private land. It is recommended that further analysis be done on this project's data to attempt to identify the *Tyto* owl species that has been unable to be identified so far. And, that this study continue to monitor areas of the park and surrounding region to increase the opportunities to verify further bird species as this information is valuable to park management planning, biodiversity protection and revegetation planning.

Running this research on private land, as well as within the state park, has proved to be a valuable educational tool for local landholders within the Landcare network. With private land providing 67.5% of species detected in this study, landholders can realise the value of revegetating areas of their land to provide bird habitat across the region. Indeed private land revegetation may be more species-rich which could account for the greater diversity of bird species over the state park. It is recommended that future research analyse the vegetation composition at each site to provide for more detailed analysis of habitat requirements and bird species presence. Promoting the value of planting a range of species in revegetation efforts will be a useful tool for future revegetation plans in the region.

Only one listed threatened species was detected, Powerful Owls in Mount Worth State Park. The lack of Powerful Owls, a tree hollow-dependent species, on private land may indicate the need for greater protection of older remnant vegetation or the need to protect revegetation areas to mature further. All private landholders who participated in this study were provided with a 10-minute soundscape of bird calls detected on their property. This will assist with increasing familiarity of landholders with the local bird species.

Finally, the Mount Worth Communities Listening for Nature Project provides an excellent example of the NatureWatch model, bringing together the local community with scientists and land managers to improve our collective understanding of species and ecosystems and to inform revegetation efforts. It has added a vast amount of audio data to Museums Victoria's online collections for future analysis and comparison and to the further development of species recognisers to support faster and more accurate analysis in future while broadening community knowledge and engagement across the region.

## 5. References

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## Appendix 1:

Overview of site recording days, rotations and length of time recordings were collected.

Site	Date SM Set	Data Collected	Days of data collection
MWC001	9/8/2016	14/9/2016	36
	14/9/2016	27/10/2016	43
	27/10/2016	28/11/2016	31
	•	Total	110
SEC002	9/8/2017	14/9/2016	36
	•	Total	36
STOR01	9/8/2016	14/9/2016	36
	14/9/2016	27/10/2016	43
	27/10/2016	28/11/2016	31
		Total	110
MWMR01	14/9/2016	27/10/2016	43
	27/10/2016	28/11/2016	31
		Total	74
KEMR02	16/9/2016	29/10/2016	43
	29/10/2016	2/12/2016	35
		Total	78
BUOR01	1/2/2017	3/3/2017	30
	3/3/2017	4/4/2017	32
	4/4/2017	5/5/2017	31
	5/5/2017	16/6/2017	42
	16/6/2017	21/7/2017	35
	21/7/2017	22/8/2017	32
		Total	202
BUNR02	1/2/2017	3/3/2017	30
	3/3/2017	4/4/2017	32
	4/5/2017	5/5/2017	30
	5/5/2017	16/6/2017	42
	21/7/2017	22/8/2017	32
	22/8/2017	22/9/2017	31
		Total	197
BUMR03	1/2/2017	3/3/2017	30
	3/3/2017	4/4/2017	32
	4/4/2017	4/5/2017	30
	4/5/2017	16/6/2017	43
	16/6/2017	21/7/2017	35
	21/7/2017	22/8/2017	32
	22/8/2017	22/9/2017	31
		Total	233
MCCO01	10/2/2007	3/3/2017	21
	3/3/2017	4/4/2017	32
	4/4/2017	5/5/2017	30
	5/5/2017	16/6/2017	42
		Total	125

Site	Date SM Set	Data Collected	Days of data collection
SEER02	15/2/2017	4/3/2017	17
	4/3/2017	6/4/2017	33
	6/4/2017	6/5/2017	29
	6/5/2017	16/6/2017	41
		Total	120
MWOR03	15/2/2017	4/3/2017	17
	4/3/2017	4/4/2017	31
	4/4/2017	5/5/2017	30
	5/5/2017	16/6/2017	42
		Total	120
MWCO02	24/6/2017	13/7/2017	19
	13/7/2017	)17 22/8/2017	
	22/8/2017	23/9/2017 3	
		Total	91
MWMR02	24/6/2017	14/7/2017	20
	14/7/2017	22/8/2017	39
	22/8/2017	23/9/2017	32
		Total	91
STOR02	24/6/2017	13/7/2017	19
	13/7/2017	22/8/2017	40
	22/8/2017	23/9/2017	32
		Total	91

## Appendix 2:

Bird detection recordings collected in this study by site and by land tenure. Species in bold are not currently listed on the Global Biodiversity Information facility for the Mount Worth State Park.

	Priv	ate L	and								Stat	e Par	k
SPECIES	B U M R 03	B U N R 02	B U O R 01	K E M R 02	PI C O 01	PI E R 01	SE E R 02	ST O R 01	ST O R 02	M W C 0	M W C 0 02	M W M R 01	M W O R 03
Australian King-parrot		1											
Australian Magpie				1	1			1					
Australian Owlet-nightjar										3			
Australian Raven								1					
Bassian Thrush										1			
Brown Thornbill										1		1	
Brush Bronzewing								1					
Common Blackbird (introduced)				1	1								
Corella species				2									
Crimson Rosella					6								
Eastern Whipbird					1								
Eastern Yellow Robin										3			
Fan-tailed Cuckoo										2			
Galah					1		1						
Gang-gang Cockatoo							3		1				
Golden Whistler				2				2					
Grey Butcherbird				1	1								
Grey Fantail				1	1								
Grey Shrike-thrush										1			
Laughing Kookaburra										1			
Magpie-lark					2								
Masked Lapwing	1	1	1										
Noisy Miner	1												
Olive Whistler					3								
Pied Currawong										1			
Pilotbird											1		
Powerful Owl											2		2
Red Wattlebird								1				1	
Rose Robin					2								
Southern Boobook										3			
Spotted Pardalote				1				1					
Striated Pardalote							1						
Sulphur-crested Cockatoo										1			
Superb Fairy-wren				1		1							
Tawny Frogmouth	2												
Tyto species	4	1	1		1			1		2			
White-browed Scrubwren					1								
White-throated Treecreeper										1			
Yellow-faced Honeyeater				1	1								
Yellow-tailed Black-cockatoo								1		1			

## Appendix 3:

List of species within and around Mount Worth State Park from Global Biodiversity Information Facility (https://www.gbif.org/) occurrence records and classification on the List of Threatened Vertebrate Fauna in Victoria advisory list (DSE 2013). **Species detected in this study are in bold.** 

Species	Common Name	Victorian Advisory List Status
Anthus novaeseelandiae	Australasian Pipit	
Anas rhynchotis	Australasian Shoveler	Vulnerable
Gymnorhina tibicen	Australian Magpie	
Pelecanus conspicillatus	Australian Pelican	
Corvus coronoides	Australian Raven	
Tadorna tadornoides	Australian Shelduck	
Threskiornis molucca	Australian White Ibis	
Chenonetta jubata	Australian Wood Duck	
Zoothera lunulata	Bassian Thrush	
Cygnus atratus	Black Swan	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	
Elanus axillaris	Black-shouldered Kite	
Neophema chrysostoma	Blue-winged Parrot	
Gerygone mouki	Brown Gerygone	
Accipiter fasciatus	Brown Goshawk	
Acanthiza pusilla	Brown Thornbill	
Melithreptus brevirostris	Brown-headed Honeyeater	
Phaps elegans	Brush Bronzewing	
Acanthiza reguloides	Buff-rumped Thornbill	
Bubulcus ibis	Cattle Egret	
Anas castanea	Chestnut Teal	
Phaps chalcoptera	Common Bronzewing	
Phylidonyris pyrrhopterus	Crescent Honeyeater	
Falcunculus frontatus	Crested Shrike-tit	
Platycercus elegans	Crimson Rosella	
Ardea modesta	Eastern Great Egret	Vulnerable
Platycercus eximius	Eastern Rosella	
Acanthorhynchus tenuirostris	Eastern Spinebill	
Psophodes olivaceus	Eastern Whipbird	
Eopsaltria australis	Eastern Yellow Robin	
Cacomantis flabelliformis	Fan-tailed Cuckoo	
Petroica phoenicea	Flame Robin	
Eolophus roseicapilla	Galah	
Callocephalon fimbriatum	Gang-gang Cockatoo	
Pachycephala pectoralis	Golden Whistler	
Cracticus torquatus	Grey Butcherbird	
Strepera versicolor	Grey Currawong	

Species	Common Name	Victorian Advisory List Status
Rhipidura albiscapa	Grey Fantail	
Colluricincla harmonica	Grey Shrike-thrush	
Anas gracilis	Grey Teal	
Aythya australis	Hardhead	Vulnerable
Poliocephalus poliocephalus	Hoary-headed Grebe	
Chrysococcyx basalis	Horsfield's Bronze-cuckoo	
Sericornis magnirostra	Large-billed Scrubwren	
Dacelo novaeguineae	Laughing Kookaburra	
Meliphaga lewinii	Lewin's Honeyeater	
Hieraaetus morphnoides	Little Eagle	
Corvus mellori	Little Raven	
Grallina cyanoleuca	Magpie-lark	
Vanellus miles	Masked Lapwing	
Dicaeum hirundinaceum	Mistletoebird	
Falco cenchroides	Nankeen Kestrel	
Manorina melanocephala	Noisy Miner	
Pachycephala olivacea	Olive Whistler	
Anas superciliosa	Pacific Black Duck	
Strepera graculina	Pied Currawong	
Pycnoptilus floccosus	Pilotbird	
Ninox strenua	Powerful Owl	Vulnerable
Porphyrio porphyrio	Purple Swamphen	
Anthochaera carunculata	Red Wattlebird	
Neochmia temporalis	Red-browed Finch	
Climacteris erythrops	Red-browed Treecreeper	
Petroica rosea	Rose Robin	
Rhipidura rufifrons	Rufous Fantail	
Pachycephala rufiventris	Rufous Whistler	
Todiramphus sanctus	Sacred Kingfisher	
Ptilonorhynchus violaceus	Satin Bowerbird	
Myiagra cyanoleuca	Satin Flycatcher	
Petroica boodang	Scarlet Robin	
Chrysococcyx lucidus	Shining Bronze-cuckoo	
Zosterops lateralis	Silvereye	
Ninox novaeseelandiae	Southern Boobook	
Pardalotus punctatus	Spotted Pardalote	
Threskiornis spinicollis	Straw-necked Ibis	
Acanthiza lineata	Striated Thornbill	
Cacatua galerita	Sulphur-crested Cockatoo	
Malurus cyaneus	Superb Fairy-wren	
Menura novaehollandiae	Superb Lyrebird	
Podargus strigoides	Tawny Frogmouth	
Daphoenositta chrysoptera	Varied Sittella	

Species	Common Name	Victorian Advisory List Status
Aquila audax	Wedge-tailed Eagle	
Hirundo neoxena	Welcome Swallow	
Haliastur sphenurus	Whistling Kite	
Sericornis frontalis	White-browed Scrubwren	
Lichenostomus leucotis	White-eared Honeyeater	
Egretta novaehollandiae	White-faced Heron	
Columba leucomela	White-headed Pigeon	
Melithreptus lunatus	White-naped Honeyeater	
Hirundapus caudacutus	White-throated Needletail	Vulnerable
Cormobates leucophaea	White-throated Treecreeper	
Rhipidura leucophrys	Willie Wagtail	
Acanthiza nana	Yellow Thornbill	
Caligavis chrysops	Yellow-faced Honeyeater	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	
Calyptorhynchus funereus	Yellow-tailed Black-cockatoo	
	Introduced species	
Turdus merula	Common Blackbird	
Sturnus vulgaris	Common Starling	
Fulica atra	Eurasian Coot	
Alauda arvensis	Eurasian Skylark	
Carduelis carduelis	European Goldfinch	
Passer domesticus	House Sparrow	
Streptopelia chinensis	Spotted Dove	



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