

# Melbourne Water Regional Bird Monitoring Project. Annual report 2016-17

Kerryn Herman

December 2017

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## Executive Summary

Melbourne Water requires an index – or ‘score’ – for rivers, estuaries, wetlands and floodplains that will show changes in ecological condition in response to management interventions over a 20-year timeframe, and which permits reporting every 5-6 years on changes across the region at appropriate spatial scales.

The results of the Melbourne Water Regional Bird Monitoring Project (MWrbm), which is part of the larger Healthy Waterways strategy, will ultimately derive a metric score for wetlands and waterways based on bird community ‘condition’. Birds are widely acknowledged as good indicators of ecological condition as they are; 1) sensitive to change in physical, chemical and biological properties and 2) sufficiently detectable and inexpensive to monitor.

The Melbourne Water Regional Bird Monitoring project has been running for five years. Over this time almost 10,000 surveys have been undertaken across 235 fixed long-term monitoring sites. This data provides Melbourne Water with a substantial robust baseline dataset to direct management and on ground activities.

With five years of data available, a comprehensive assessment of the bird communities across the Port Phillip and Westernport region has been undertaken, exploring survey effort and species accumulation, as well as applying the developed avian sub-index and a standard ecological diversity index. These indices allow for the long term assessment of the bird communities, and potentially the ecological condition of the defined monitoring site. Riparian communities are stable or improving in the sub-index score, whilst a decline is seen across the wetland index. This is believed to be in response to better inland conditions in 2016. The variability in the bird communities across the catchment is highlighted in the application of the ecological diversity index.

Melbourne Water estate continues to support priority conservation bird species, listed at both state and federal levels, as well as a range of migrant species. Records of Sharp-tailed Sandpiper at Edithvale have been consistently above 1% of the global population, suggesting this site may be eligible for inclusion in the East Asian – Australasian Fly Partnership. Melbourne Water already manages two sites recognised under this partnership.

With the growing database at the site level, long term trends in these communities can be explored. Seaford, Edithvale and Braeside Park (Carrum KBA) are explored in detail, as are five of the Dandenong constructed wetlands. Longterm changes in the count data for several species are observed, which may warrant requirement for a management response.

## 1) Introduction

The 2016-17 period is the fifth year of bird monitoring across the Port Phillip and Westernport Catchment area. Across this region, Melbourne Water is responsible for the management of waterways and wetlands, many of which are areas of high biodiversity value in the increasingly urbanised landscape. The quality of natural assets on land and waterways managed by Melbourne Water ranges from internationally recognized Ramsar wetlands, forested closed water supply catchments supporting rare and threatened species and communities, through to constructed storm and waste water facilities.

Native biodiversity is of increasing interest to the broader community, and its protection is enforced through legislation such as the *Flora & Fauna Guarantee Act 1988* (Vic.), the *Catchment & Land Protection Act 1994* (Vic.), Victoria's Native Vegetation Management Framework and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth). Recognising the important role waterway management plays in environmental health and community liveability, Melbourne Water developed the *Healthy Waterways Strategy* (HWS) as a guide to investments in the Port Phillip and Westernport region from 2013

([www.melbournewater.com.au/sites/default/files/2017-09/HealthyWaterwaysStrategy\\_1\\_Executive-summary.pdf](http://www.melbournewater.com.au/sites/default/files/2017-09/HealthyWaterwaysStrategy_1_Executive-summary.pdf)). The HWS in conjunction with the Stormwater Strategy provides an opportunity to broaden the definition of river health to include key ecosystem elements which will benefit fauna and associated habitats beyond that of native fish, such as watering regimes of floodplains and wetlands and riparian wildlife, including birds.

One of the key elements of assessing the biodiversity values across the Melbourne Water managed land, as well as directing onground management, has been the exploration of an index to measure changes in the bird communities in response to changing onground conditions. These changes should reflect the onground management and works undertaken by Melbourne Water, as bird communities (or representative species) should be responsive to the changing habitat elements –whether it be water levels, structural elements or canopy cover that are influenced by the active management implemented by Melbourne Water.

During this process, Melbourne Water commissioned a number of explorative studies to develop an avian sub-index to increase understanding of the association between waterway management works and riparian bird assemblages (AECOM 2011, 2012. Steele 2011). Numerous studies have advocated the use of birds as ecological indicators (Canterbury *et al.* 2000, Fleishman *et al.* 2005, Ehmke *et al.* 2015) however detectable changes in bird communities in response to management interventions, such as revegetation may occur on various time scales, from years (O'Neill 1999, Radford *et al.* undated a, undated b, 2004, Olsen *et al.* 2005, Munro *et al.* 2007, Lee *et al.* 2010 and Paton & O'Connor 2010) to decades (Vesk & MacNally 2006, Vesk *et al.* 2008, Loyn *et al.* 2007). 'Condition scores' resulting from the avian sub-indices would ideally permit reporting every 5 years on changes across the region at appropriate spatial scales and allow suitable targets for biodiversity conservation and rehabilitation to be identified.

The 2016-17 survey period is the fifth year the Melbourne Water Regional Bird Monitoring program has been running. This program has been a co-operative effort between Melbourne Water and BirdLife Australia staff and volunteers. This five year mark provides a key time frame to undertake a wider assessment of the collected data, and this report aims to look at the results of the five year project, rather than an annual assessment as has been presented in previous years.

## 2) Methods

### Site identification

In order to prioritize wetlands and waterways of high biodiversity value the following hierarchy of site significance for monitoring was established by Melbourne Water at project commencement.

Categories are defined as follows:

1. Ramsar listed wetlands and Key Biodiversity Areas (KBAs<sup>1</sup>). Criteria for listing include:
  - **Criterion 2:** A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
  - **Criterion 5:** A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
  - **Criterion 6:** A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
2. Melbourne Water Sites of Biodiversity Significance (SoBS) (Ecology Australia 2013b). Criteria for listing include:
  - **Criterion 1:** Land ownership- The land is owned and/or managed by Melbourne Water's Waterways Group.
  - **Criterion 2:** EPBC Act - Site support item(s) listed under the EPBC Act; communities and/or threatened species populations. Site may also be part Ramsar Wetland and/or supports important Migratory and/or Marine-Overfly species.
  - **Criterion 3:** FFG Act - Site supports item(s) listed under the FFG Act: species and/or communities.
  - **Criterion 4:** Threatened EVC(s) – Site is known to support threatened EVC(s), i.e. those listed as bioregionally Vulnerable or Endangered.
  - **Criterion 5:** Advisory Listed Flora/ Fauna (DSE 2013) – Site is known to support threatened species population(s)
  - **Criterion 6:** Connectivity - the site demonstrates habitat connectivity for threatened species.
3. Selected Melbourne Water Works sites – works include willow treatment sites.
4. Other - As many sites as possible centered within 250 meters of waterways and wetlands (Melbourne Water sites, DSE biosites (DNRE 2002, DSE 2005) , significant council managed wetlands etc)
5. Dandenong Valley, Melbourne Water constructed wetland case study sites<sup>2</sup>.

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<sup>1</sup> Important Bird Areas (IBA's) have been expanded to include other biodiversity values by BirdLife International and the IUCN. Areas that were declared IBAs are now part of the Key Biodiversity Area (KBA) network.

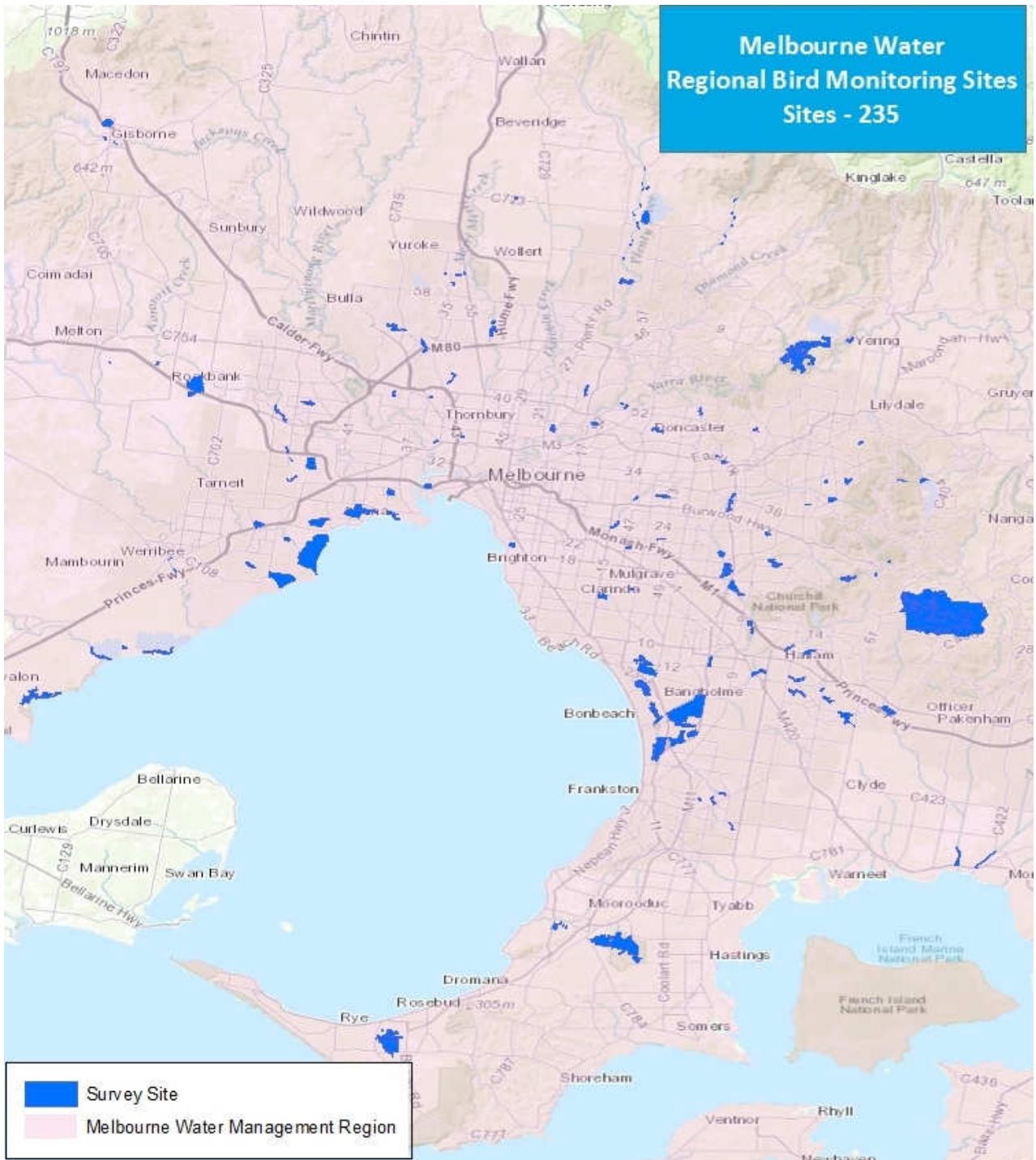
<sup>2</sup> These sites, which were established as a case study into habitat utilisation at constructed wetlands in 2007, are no less significant than those in category 4 however are referred to in a separate category due to their different particular data collection methods.

**Table 1. Summary of survey categories and justification.**

Category	Site Type	Purpose
1	Ramsar IBA	<ul style="list-style-type: none"><li>• To support compliance reporting of bird population trends and community composition.</li><li>• To monitor key bird values, whether species, guilds or communities and determine trajectories over time.</li><li>• To evaluate works and management at sites.</li></ul>
2,4,	SoBS Melbourne Water sites	<ul style="list-style-type: none"><li>• To monitor key bird values, whether species, guilds or communities and determine trajectories over time.</li><li>• To evaluate works and management at sites.</li></ul>
3	Works evaluation sites.	<ul style="list-style-type: none"><li>• To evaluate effectiveness of specific works on bird community.</li></ul>
4	Sites centred within 250m of waterways and wetlands	<ul style="list-style-type: none"><li>• To collect sufficient data (n = 40+ surveys) to generate bird sub-index across the region every five years.</li></ul>
5	Dandenong Valley constructed wetlands	<ul style="list-style-type: none"><li>• To monitor key bird values, whether species, guilds or communities and determine trajectories over time.</li><li>• To evaluate works and management at sites.</li><li>• Assess habitat utilisation at constructed wetlands</li></ul>

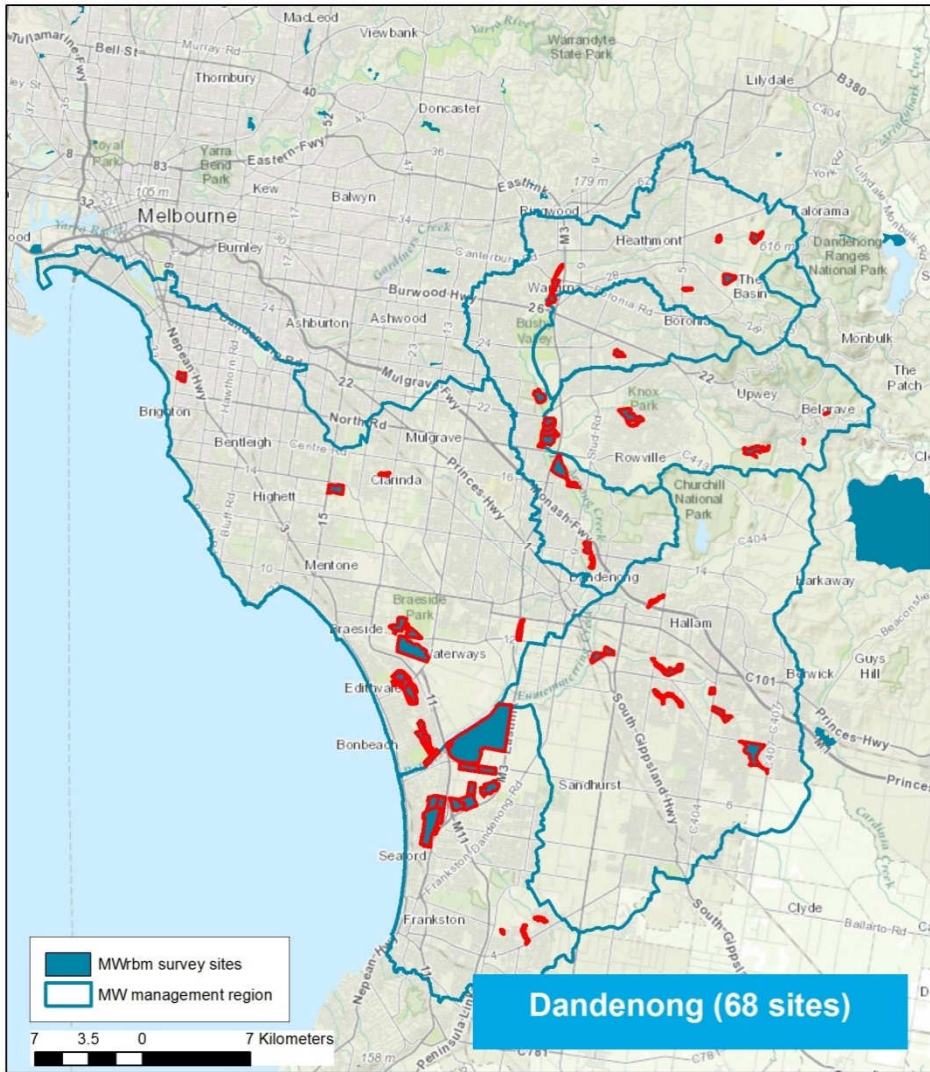
### **Mapping**

Based on a combination of ground-truthing, observer consultation and interpretation from aerial images, boundaries of wetland and waterway survey sites were digitized and incorporated into a central Melbourne Water GIS layer (Figures 1 -6). The layer adds another tier to the data extraction process and enables identification of sites that have been targeted for regular, standardized surveying.



**Figure 1. Wetland and waterway sites identified for targeted surveys as part of the MWRbm.**

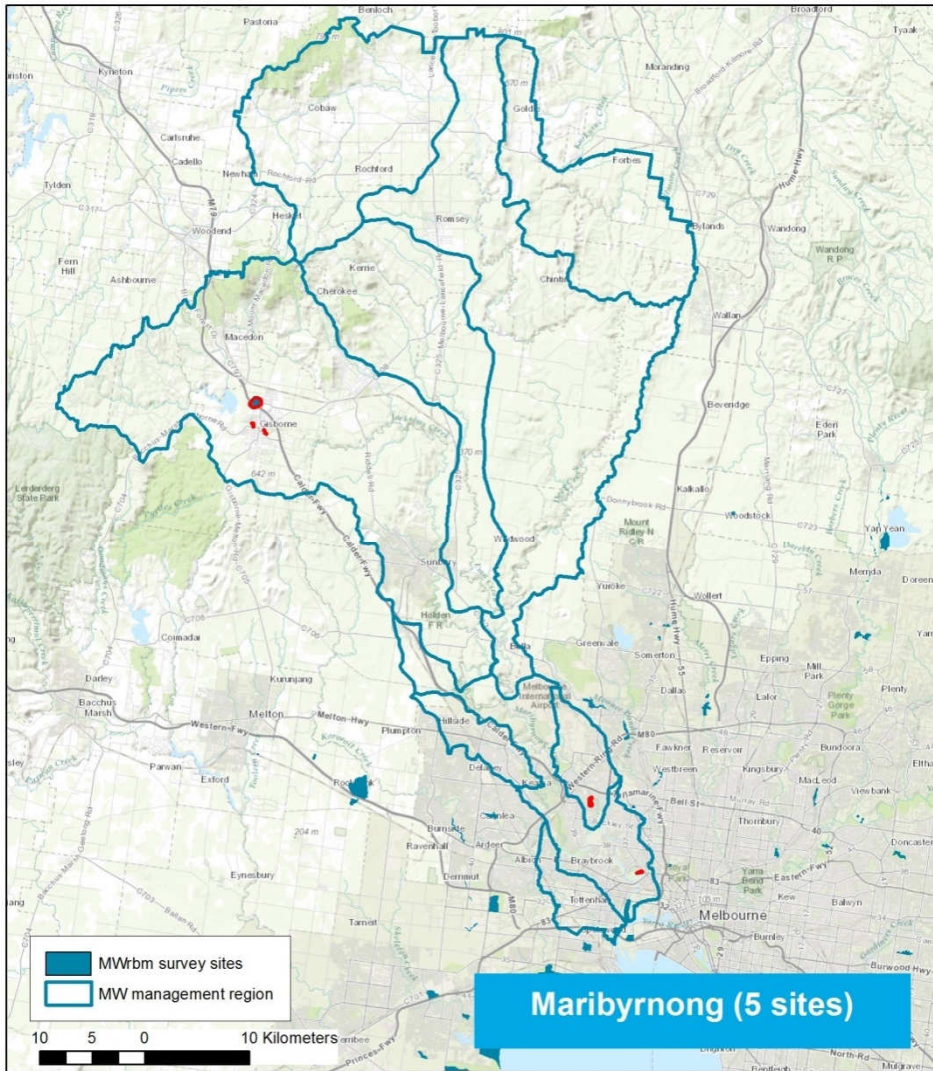




**Table 2. MWRbm sites within the Dandenong Catchment by management unit.**

<b>Blind Creek</b>	<b>Eumemmerring</b>
Patterson River	Hallam Valley Floodplain
Lakewood Park Res, Riddel Road Retarding Basin	Frog Hollow Wetland, Eumemmerring Creek
Dandenong Wetlands, Koomba Park	Hallam Valley Floodplain, O'Grady Road
<b>Dandenong Creek Lower</b>	Troups Creek
Edithvale - Zone 1	Kilberry Boulevard, Hampton Park East Drain
Edithvale - Zone 2	Berwick Springs wetlands
Edithvale - Zone 3	Golf Links Road
Edithvale - Zone 4	River Gum Creek Reserve, Hampton Park East
Edithvale - Zone 5	Dwarf Galaxia Conservation Wetland, Cranbou
Edithvale - Zone 8	<b>Kananook</b>
Edithvale - Zone 6	PARCS Wetland, Eel Race Drain, ETP
Edithvale - Zone 7	Seaford Wetlands - Zone 1
Edithvale Common	Seaford Wetlands - Zone 2
Wannarkladdin Wetlands - east	Seaford Wetlands - Zone 3
Wannarkladdin Wetlands - west	Seaford Wetlands - Zone 4
Wannarkladdin Wetlands - north	Seaford Wetlands - Zone 5
Elsternwick Park	Seaford Wetlands - Zone 6
Karkarook Park	Boundary Road Wetland, Eel Race Drain, ETP
Woodlands Estate Wetlands	Little Boggy Creek Retarding Basin
Springvale rd Wetlands, Mordiallock Creek	Boogy Creek Waterway reserve
Braeside Park	ETP turf farm
Greens Rd wetlands	ETP Rossiter Rd Lagoon (beside Banyun)
Namatjira Wetlands, Clayton South	ETP south, Serpentine area
<b>Dandenong Creek Middle</b>	Eastern Treatment Plant (ETP)
Tirhatuan Wetlands, Dandenong Creek	Boggy Creek Waterway Reserve, Boggy Creek
Colchester Road Retarding Basin, Bungalook Creek	The Doughnut, Eastern Treatment Plant
Liverpool Road Retarding Basin, Dandenong Creek	Tamarisk Waterway Reserve, Langwarrin
Fussel Road Retarding Basin, Bungalook Creek	<b>Corhanwarrabul, Monbulk and Ferny Creeks</b>
Old Joes Creek Retarding Basin, Old Joes Creek	Birdsland, Monbulk Creek Retarding Basin
Heatherton Road South	Waterford Wetlands, aka Karoo Road Wetland
Koomba Park North	Monbulk Creek Upstream Control
Heatherton Road North	Monbulk Creek Works Site
Police Rd retarding basin Wetland	Rigby's Wetland (4 sites)
Jells Park Lake	Mulgrave reserve Wetland
Winton Wetlands	

**Figure 2. MWRbm sites within the Dandenong Catchment.**



**Table 3. MWrbm sites within the Maribyrnong Catchment by management unit.**

Jacksons Creek
Jacksons Creek Downstream Control
Jacksons Creek Works Site
Gisborne Swamp
Maribyrnong River
Flemington Racecourse
Steele
Valley Lake Reserve

**Figure 3. MWrbm sites within the Maribyrnong Catchment**



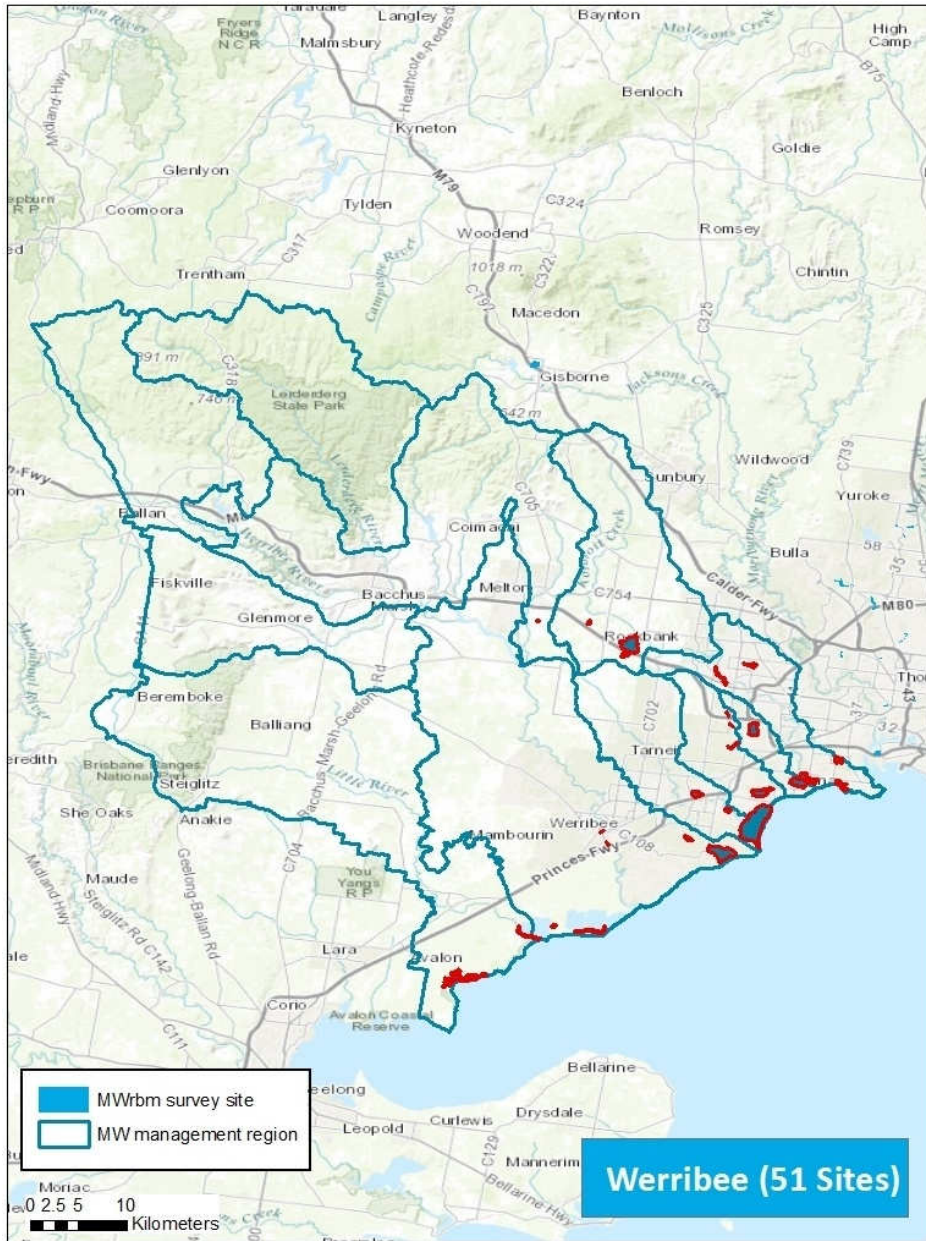
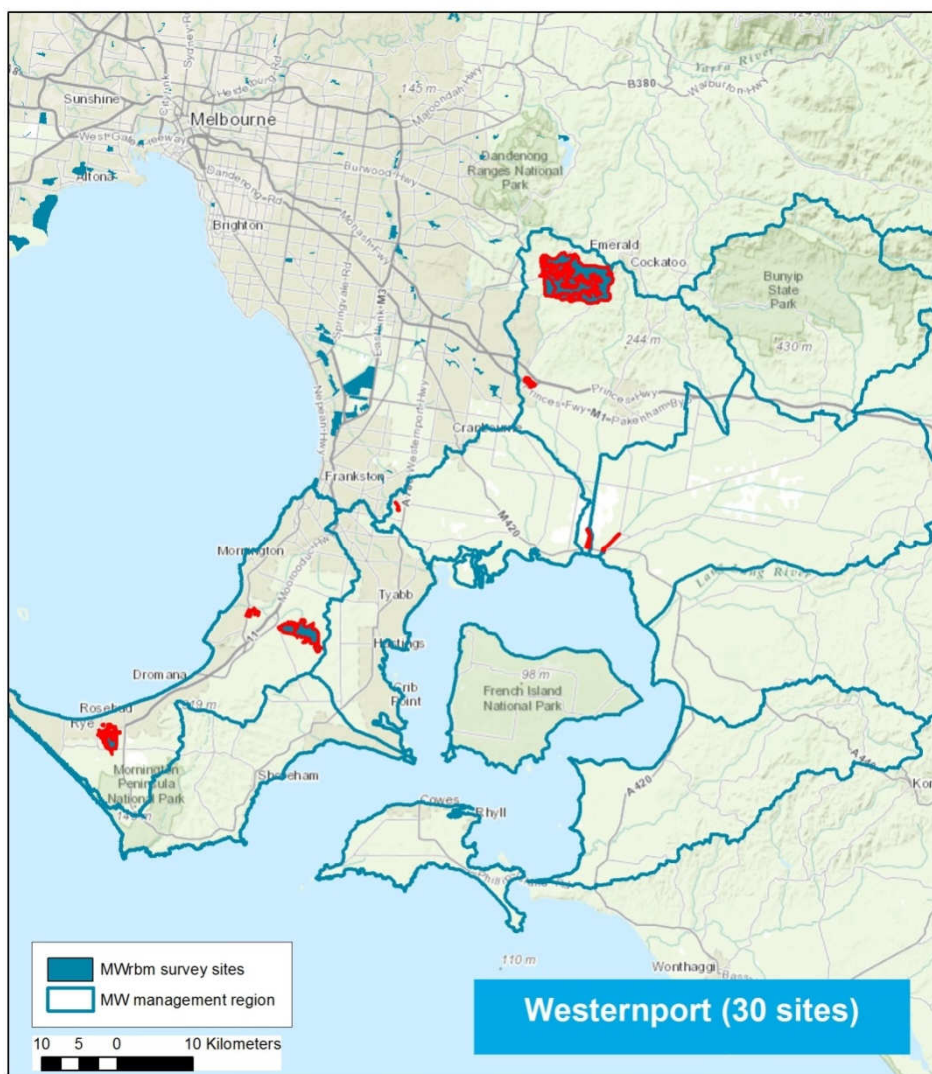


Figure 4 .MWrbm sites within the Werribee Catchment.

Table 4. MWrbm sites within the Werribee Catchment by management unit.

<b>Cherry Main Drain</b>	WTP – Pond Q4
Fitzgerald Rd Grasslands & Andersons lake	<b>Skeleton Creek</b>
Cherry Lake, Cherry Creek	Williams Landing (Cedar Woods)
<b>Kororoit Creek Lower</b>	Skeleton Creek Saltmarsh, Skeleton Creek
Kororoit Creek Escarpments south, Kororoit Creek	Cheetham Saltfields (Parks Victoria)
Iramoo Wetlands	<b>Werribee Lower</b>
Kororoit Creek Escarpments north, Kororoit Creek	WTP - 35E Pond 9 Conservation Pond
Cherry Lake north, Big Bend	Cunningham Swamp South
Lower Koroit Creek Waterway Reserve, Koroit Creek	Cunningham Swamp North
Jawbone Reserve, Williamstown	WTP - 85WC Pond 9
Newport Lakes	WTP - 5W Pond 11
<b>Kororoit Creek Upper</b>	WTP - 5W Pond 9
Troups Road Swamp	WTP - 35E Pond 8 Conservation Pond
Deans Marsh, Rockbank	WTP -115E Experimental Ponds 1 to 4
Paynes Road North Swamp	WTP - 270S Borrow Pit
<b>Laverton</b>	WTP - 95E North
Truganina Swamp, Laverton Creek	Werribee River Downstream Control
Kayes & Imms Creek Waterway Reserve, Laverton	Werribee River Works Site
Kayes Creek Waterway Reserve, Windsor Blvd	RAAF Lake
Kayes Creek Waterway Reserve, Yeend Crt Derrimut	WTP - 5W Pond 10
<b>Little River</b>	<b>Werribee Middle</b>
WTP - T Section Lagoon 6	Abbey Rd Wetlands, Melton South
WTP - T Section Lagoon 7	
WTP - Summer Pond 1	
WTP - Summer Pond 2	
WTP - Western Lagoon Ponds 4&5 (rehab)	
WTP - Western Lagoon 6	
WTP - Western Lagoon 3	
WTP - Western Lagoon 7	
WTP - T Section Lagoon 1	
WTP - T Section Lagoon 3	
WTP - Western Lagoon 8	
WTP - Western Lagoon 9	
WTP - Little River, Lower Reaches	
WTP - T Section Lagoon 2	
WTP - T Section Lagoon 5	
WTP - T Section Lagoon 4	



**Table 5. MWRbm sites within the Westernport Catchment by management unit.**

<b>Cardinia, Toomuc, Deep and Ararat</b>
Cardinia Creek Retarding Basin, Cardinia Creek
The Inlets Waterway Reserve, Cardinia
Cardinia Reservoir
Cardinia res - Predominantly introduced veg
Cardinia res - Lowland forest
Cardinia res - Damp heathy woodland
Cardinia res - Shrubby Gully Forest
Cardinia - Open water
Cardinia res - Banksia woodland
Dalmore Outfalls
Leisureland Drive drain
Leisureland Drive Wetland
<b>Lower Bunyip</b>
Koo Wee Rup Tower
<b>West Peninsula Rivers and Creeks</b>
Tootgarook swamp - B Gahnia swamp
Tootgarook Swamp, McNaught accumulative
MPS Tootgarook Wetland Reserve boundary
Tootgarook Swamp 92W
Woods Reserve
Devilbend Reservoir
Bittern Reservoir
Briars Woodland
Briars Western Tributary
Briars Central Tributary
Briars Eastern Tributary
Truemans Road Landfill
Industrial Estate Retarding Basin
Sanctuary Park Reserve
Tootgarook swamp - D Moona swamp 2
Tootgarook swamp - C Moona swamp
Tootgarook swamp - A McNaughts lake
Tern Ave Wetland

**Figure 5. MWRbm sites within the Westernport catchment.**



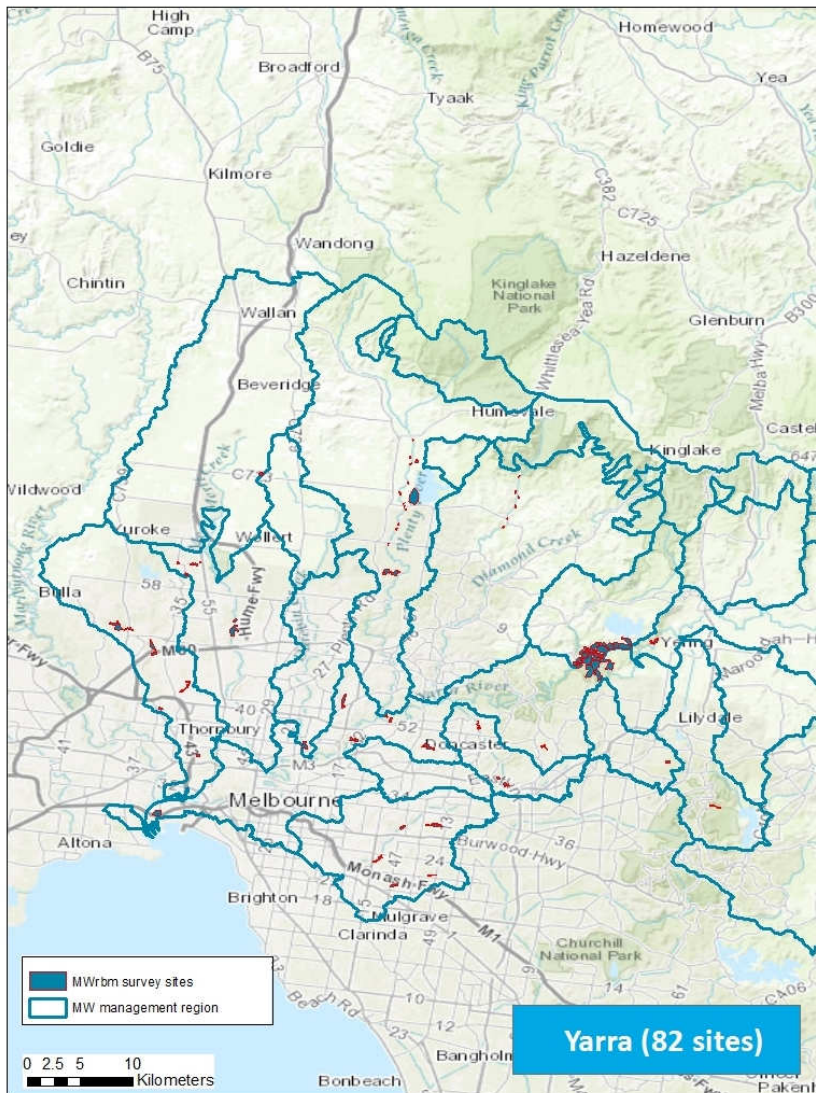


Figure 6. MWrbm sites within the Yarra catchment.

Table 6. MWrbm sites within the Yarra Catchment by management unit.

<b>Brushy Creek</b>	<b>Mullum Mullum</b>
Cardigan Road Retarding Basin, Mooroolbark Creek	Mullum Mullum Park
<b>Darebin Creek (Urban)</b>	Mullum Mullum Creek Currawong Park
Darebin Parklands	Yarran Deheran Reserve
Works evaluation - site 16	<b>Olinda Creek</b>
Works evaluation - site 15	Olinda Creek, control
Works evaluation - site 14	Olinda Creek Works (2 sites)
Works evaluation - site 13	Silvan Reservoir
Works evaluation - site 12	<b>Plenty River (Rural and Lower)</b>
Works evaluation - site 11	Works evaluation - site 9
<b>Gardiners</b>	Works evaluation - site 8
Gardiners Creek – Station St to Burwood Highway	Works evaluation - site 6
Jingella Park – Gardiners Creek	Works evaluation - site 1
Huntingdale Wetlands	MWPG- Marshland/Carex/Tortoise Pond
Ashwood – Queens Parade	MWPG- North East Wetland
Wurundjeri Walk, BlackburnSth	MWPG- Mother in Law's Leap
Valley Reserve retarding Basin, Waverly	Dunnetts Road Swamp, Plenty River
<b>Kororoit Creek Lower</b>	Works evaluation - site 2
Newport Lakes	Works evaluation - site 3
<b>Merri Creek (Rural and Forested)</b>	Works evaluation - site 10
Donnybrook Rd Lake	Works evaluation - site 7
<b>Merri Creek (Urban)</b>	Works evaluation - site 5
Galada Tamboore South, Merri Creek	Works evaluation - site 4
Galada Tamboore, Merri Creek	Yan Yean Reservoir Park
Lakeside Dve Reserve	<b>Watsons Creek</b>
Wintersun Crt Reserve	Bend of Isles (15 sites)
Moir Drive Reserve East	<b>Yarra Middle</b>
Moir Drive Reserve	Murunduka Swamp
<b>Moonee Ponds</b>	Westgate Park
Trin Warren Tam-boore wetlands	Rosanna Parklands, Salt Creek
Moonee Ponds Creek, Westmeadows	Yaruk Tamboore
Jacana Wetlands (south)	Bolin Bolin Billabong
Jancana Wetlands (north)	Andersons Creek East Retarding Basin
Westbreen Creek - Gavin Park	Ruffey Lake Park
Westbreen Creek - Joyce Reserve	Bend of Isles (7 sites)
Tullamarine (Wright Street) retarding Basin,	<b>Yarra Upper (Rural)</b>
Woodlands Park, Essendon	Yering Backswamp

## Survey techniques

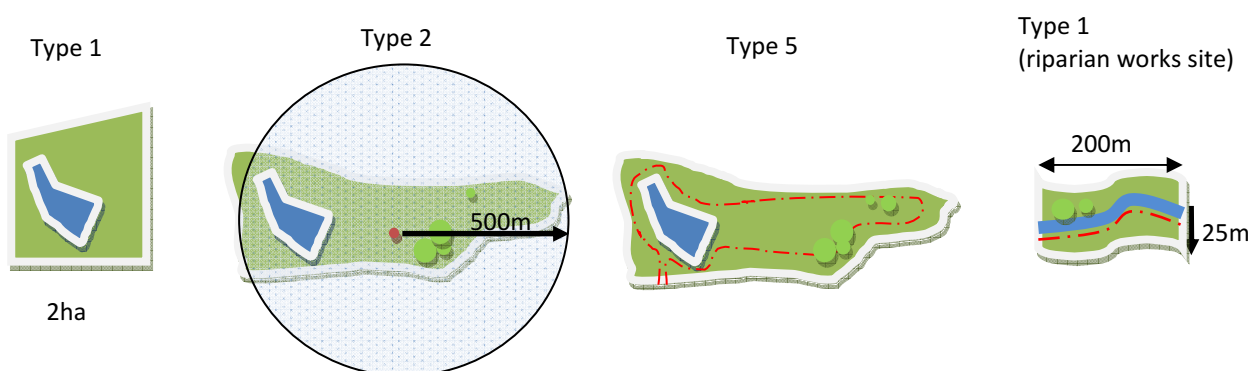
The Atlas of Australian Birds has traditionally accepted five different survey methodologies for recording birds:

- *2-ha searches* for 20 minutes (Type 1).
- *Small Area searches* for at least 20 minutes *within 500m* of a central point (Type 2).
- *Large Area searches* for at least 20 minutes *within 5km* of a central point (Type 3).
- *Incidental searches*, usually one-off sightings of unusual species or a survey where not all species are recorded (Type 4).
- *Fixed route surveys* for at least 20 minutes within 5km of a central point (Type 5).

With the exception of *Type 4* surveys which are excluded from standardised data sets, these methods were devised to accommodate surveying across different habitat types and scales while still producing consistent, comparable data (Figure 7). Of these around 40% of observers utilise the *2-ha Search*, 40% the *Small Area search* and the remainder *Large area search*, *Fixed route* and *Incidental*.

Analysis of species accumulation curves devised from Atlas data (AECOM 2012) indicate that *area searches* (either within 500m or 5 km from a point) were more effective than *2-ha* surveys for estimating bird species richness at a riparian site. Anecdotal evidence indicates that to cover these greater areas whilst recording birds, observers will require more than 20 minute survey time. For these reasons the observers contributing to MWrBm project are encouraged to complete 30 minute *Area Searches* of 500m to 5km where appropriate. For riparian surveys (including works evaluation transects) survey areas are confined to a 200m transect along the waterway and 25m perpendicular from each bank. This methodology is consistent with that being used for targeted surveys of a subset of riparian works evaluation sites (Project C - AECOM). Where sites are larger than 500m from a point or consist of several distinct habitats which may be subject to separate management regimes, surveys are broken into subzone (eg. Edithvale zones 1-8). This enables a finer spatial assessment of habitat condition.

**Figure 7. A representation of 4 common standardised survey types used in the MWrBm project.**



The recent development of the *Group Site* platform for registering sites has increased the accessibility of project sites to the wider BirdLife constituency. Participants are encouraged to register a *Group Site* on the Birddata portal which is accessible to all other registered users. MWrBm sites have been mapped and identified as belonging to the program and included in the birdlife Group Site system. This encourages consistent surveying between observers by outlining site boundaries, access points, directions to site, survey methodology and lists species observed on previous surveys. By listing previous survey details the Group Site page also acts as a checklist for site leaders and observers to identify gaps in surveying spatially and temporally.

To increase the consistency between surveys, observers are encouraged to commit to surveying a site monthly or quarterly. This not only improves the robustness of the data but also increase the ability of the observer to comment on habitat or management changes which may be effecting bird diversity and/or abundances.

The minimum frequency of data collection (quarterly or monthly) and type of data collected (presence/absence or quantitative) are dictated by site significance (Table 7).

#### Minimum survey frequency.

The conceptual model developed as part of Project A (AECOM 2012) identified a minimum of 40 replicate surveys will be required for each site in order to effectively contribute to the avian index. At c=40 the probability of detecting new species at a site significantly declines (AECOM 2011). To achieve this goal in a timely manner, site leaders are asked to maximise survey effort while taking into account variables such as number of Atlassers sharing survey burden, accessibility, weather and observer availability.

#### Minimum data type

Observers are asked to record all species seen and heard within the site boundaries. For category 1, 2, 3 and 5 sites observers are also requested to record species abundance including estimates on birds heard within site boundaries.

**Table 7. Summary of site categories and data requirements.**

Category	Preferred survey type	Minimum frequency	Minimum data type
1	Fixed route survey (Type 5)	Monthly	Quantitative
2,4	Wetland: Area Search <500 m (Type 2) Waterway: Fixed route survey (Type 5)	Seasonal	Quantitative
3	Wetland: Area Search <500 m (Type 2) Waterway: Fixed route survey (Type 5)	Seasonal	Quantitative
4	All, except Incidental Searches	As possible	Presence/ absence
5	Area Search <500 m (Type 2)	Monthly	Quantitative + habitat/activity

#### Possible biases

There is no way of knowing what proportion of each species is counted, or detected. The methods used in this project represent a standardised replicable approach, and are the best methods currently known to provide a comprehensive inventory of species presence. The count information should be interpreted as comparable, relative information rather than as a definitive estimate of total numbers present. For example, the majority of surveys that were conducted are likely to under-represent cryptic and nocturnal species. Melbourne Water has commissioned several studies into the distribution and habitat management of cryptic species (Ecology Australia 2006a, 2007a, 2008a).

#### i) Data management and vetting.

Although all data which are submitted to the BirdLife Atlas of Australian Birds are rigorously vetted both by electronic queries on spatial distributions/reporting rates and physically by a team of regional coordinators and local experts the database may contain a small number of errors. The new BirdLife Birddata portal has additional data vetting processes built in to further decrease the likelihood of erroneous records. This includes the inclusion of species distribution polygons in the backend of the application, meaning that should a participant enter a species that is outside its known distribution, the record cannot be submitted to the data base without further information provided by the observer. This flags potential misidentification with survey participants, but also makes data vetting by the Atlas team more efficient as records are marked on submission.

## Analysis methods

A comprehensive analysis of the relationship between available data from BirdLife Australia’s Atlas of Australian Birds and Melbourne Water’s Index of Stream Condition (ISC) found that bird diversity and by extension site ‘condition’ may be derived provided adequate and appropriate bird data was available. The investigations explored the use of total species lists and the ratio of species observed at a site to those expected and identified that a minimum of 40 site based surveys are necessary before species accumulations plateaued and the presence or absence of a species from that site can be sufficiently assumed (AECOM 2011).

Steele (2011) developed an avian sub-index as a means of looking at temporal changes in the riparian and wetland communities found across monitoring sites. For this purpose 113 native riparian species and 57 native wetland species were identified (see Appendix 1) as relevant to contribute to these indices. Steele (2011) used five-year intervals in his initial report, and as such a similar frequency has been applied here. Avian sub-indices have been calculated at the catchment, management unit and site level. For catchment and management units an overall score has been obtained by pooling all five years of data together, as well as annual scores for the five survey periods. Each unit was required to have at least 40 surveys undertaken for the time period. At the site level, a single score was calculated. Sites were assessed for their overall survey effort and only sites with >40 surveys over the 2012-2017 period have had sub-indices calculated.

This index is calculated using equation 1

$$\sum_{i=1}^n \frac{Sp_i}{Stotal}$$

Where  $Sp_i$  = the number of surveys where species i is present

$Stotal$  = the total number of surveys undertaken

This is the sum of the individual reporting rates of the identified index species.

### ***Shannon Diversity Index***

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.

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). This provides a standardised way of comparing the bird diversity across sites and can be used as a long term measure of temporal changes in the bird communities at each site or across the landscape. Ideally management should aim to maintain or increase the index value over time. There is no one optimal value, as sites differ in size, vegetation and location within the landscape matrix. 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 Index is calculated by using equation 2:

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

H = Shannon Value

s= all species recorded

$p_i$  = 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.

The drawback of this method is that it requires count data to calculate the index. Not all surveys submitted to the Melbourne Water Regional Bird Monitoring project contain species counts, and as such are unable to be used in this index. Additionally, surveys where some species are counted and others are only recorded as present can be problematic in data handling and ideally should be excluded from the analysis. These constraints can lead to biases in the use of this method and as such interpretation of the results should be done knowing that not all surveys were included in the final analysis.

One of the benefits of the Shannon index is that there is not minimum number of surveys required to calculate a score, though the more surveys, the more representative the score is likely to be. This means that Shannon indices were able to be calculated for all sites across the five year survey period. A combined index was also calculated to give an overall measure of each sites biodiversity .

### 3) Occupational Health and Safety

Following a review of BirdLife OH&S procedures regarding surveying on Melbourne Water properties a revised set of Task Risk Assessments (TRA) was distributed amongst observers. Observers are required to read the relevant TRA (now available on the project page) and agree to the controls listed by signing and returning the Volunteer registration form to [ohs@birdlife.org.au](mailto:ohs@birdlife.org.au).

Any person within the BirdLife Family involved in an incident, or whom identifies a hazard pertaining to health or safety in the workplace has a responsibility to report that incident or hazard as soon as is practically possible. The first point of call is project manager Chris Purnell, in order to assess the immediate and potential risk to themselves or others. In the case a 'serious injury' or 'dangerous occurrence' has occurred, the OHS Coordinator and Worksafe representative is notified.

No incidents were reported for the reporting period. Additionally two OH &S audits were undertaken during the 2016-17 period. Generally these met the requirements of the project, however improvements were identified with the current OH&S process being refined to address the outcomes of the audit process.

## 4) Results and discussion

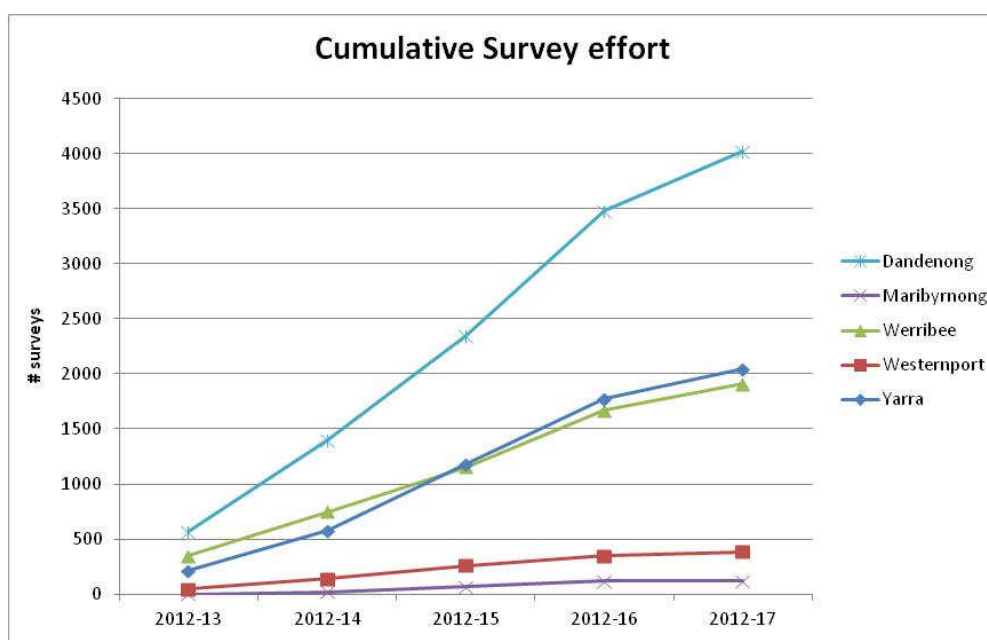
### Survey coverage

Table 8 presents the total number of standardized surveys undertaken across the Melbourne Water Regional Bird Monitoring sites for the past five years. This includes data directly contributed to the project, as well as additional surveys recorded through other avenues such as e-bird. A total of almost 10,000 surveys have been contributed by BirdLife staff and volunteers to this project. Over this period more than 2.7 million<sup>3</sup> birds have been counted across 299 species.

**Table 8 Breakdown of survey effort across MWRbm sites since the inception of the project in 2012**

	# survey sites	2012-13	2013-14	2014-15	2015-16	2016-17	Total (catchment)
Dandenong	68	557	862	1011	1115	1064	<b>4609</b>
Maribyrnong	5	1	21	48	46	18	<b>134</b>
Werribee	51	352	395	414	523	541	<b>2225</b>
Westernport	30	79	136	132	95	79	<b>521</b>
Yarra	82	216	363	610	594	617	<b>2400</b>
Total (year)	<b>2365</b>	<b>1205</b>	<b>1777</b>	<b>2215</b>	<b>2373</b>	<b>2319</b>	<b>9889</b>

Surveys across the Dandenong sub-catchment are significantly greater than other catchments. This has consistently been the case since the beginning of the project (see figure 8)



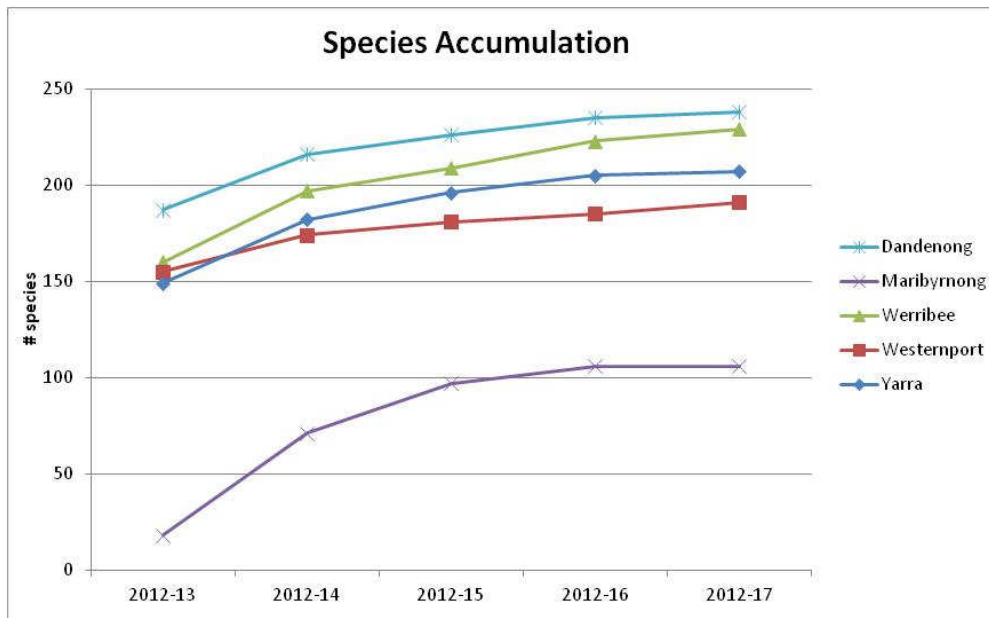
**Figure 8 Cumulative survey effort at sub-catchment scale**

Survey effort is important when considering the species diversity across the management areas. Survey effort needs to be enough to be confident that all species are being recorded, removing the risk of erroneous

<sup>3</sup> This number is a conservative estimate only. Not all survey data submitted includes a count of the individual birds observed.



conclusions about bird communities. Figure 9 shows the derived species accumulation curves for each of the five catchment areas. These all show the desired asymptoting indicating that all species occurring across regions have been detected throughout the study period. Even Maribyrnong, which has significantly less surveys than the other catchment areas shows this desired shape.



**Figure 9 Species accumulation over study period at sub-catchment level**

Survey effort and species accumulation across management units show variable results. Some units such as Dandenong Lower Creek and Darebin Creek have had consistently high levels of surveys and these have continued across the survey period. These units show expected species accumulation trends. Other units such as Dalmore Outfalls and Lower Bunyip in Westernport are substantially under surveyed. This is most likely the result of the low site numbers within the management unit, combined with limited survey effort at the defined sites. The following figures (10a and b – 14a and b) present survey effort and species accumulation for the 30 management units which have survey sites established as a part of the regional bird monitoring program.

Survey effort becomes important when considering the calculation of the avian sub-index. A minimum of 40 surveys are required to ensure that most species are accounted for. Subsequently, whilst all catchments have sufficient survey effort to undertake index calculation, a number of management units were found to be deficient in survey effort (ie <40 surveys undertaken), resulting in no index calculation.

Tables 9 - 13 present the survey effort and species count data at the site level.

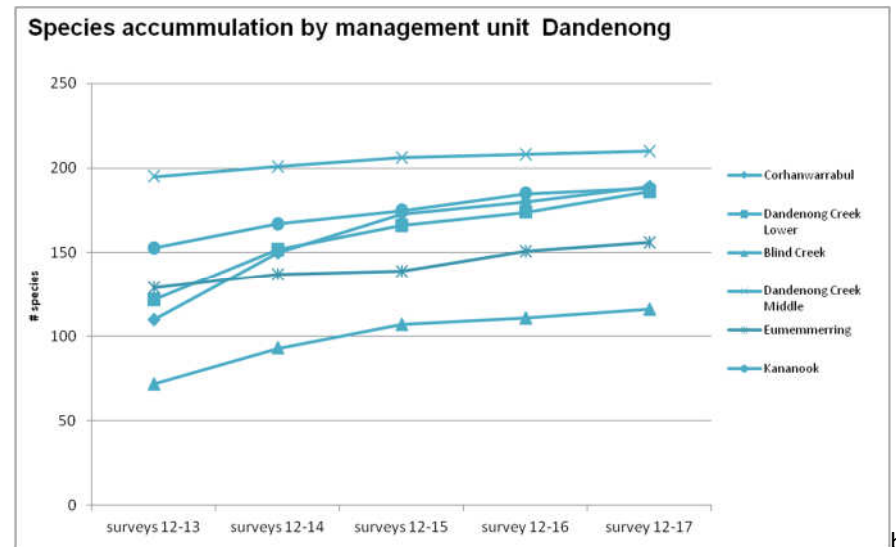
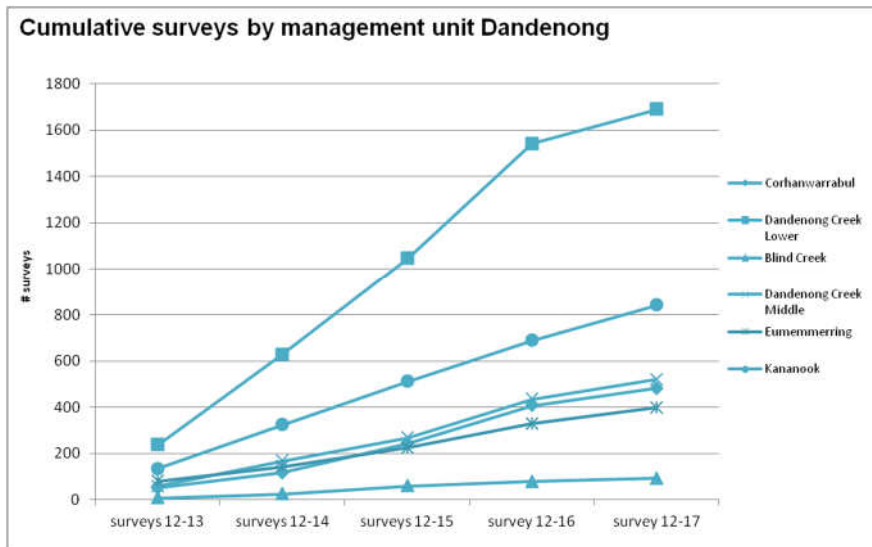


Figure 10a and b Survey effort and species accumulation across Dandenong sub-catchment by management unit

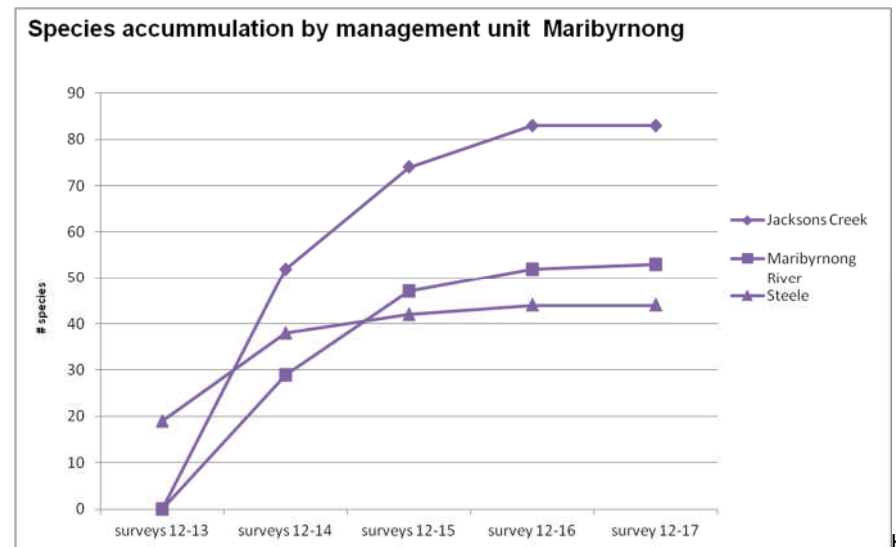
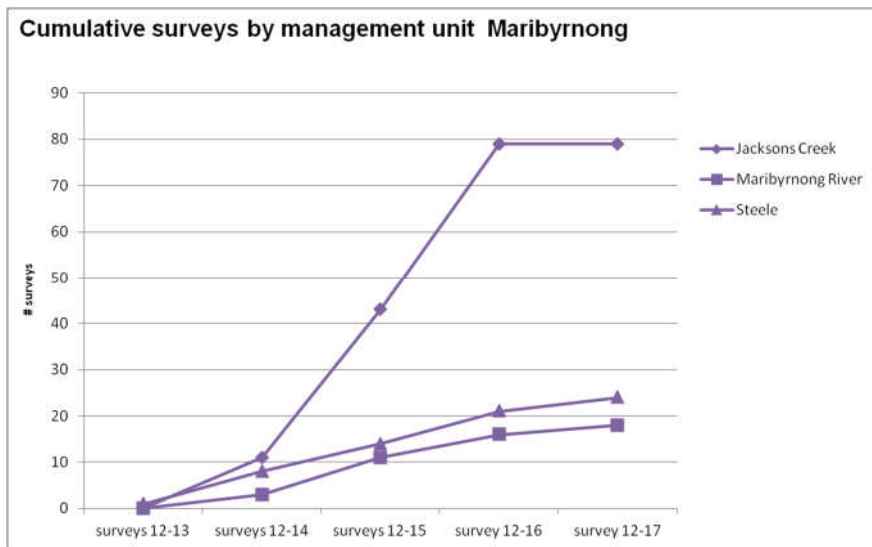


Figure 11a and b Survey effort and species accumulation across Maribyrnong sub-catchment by management unit

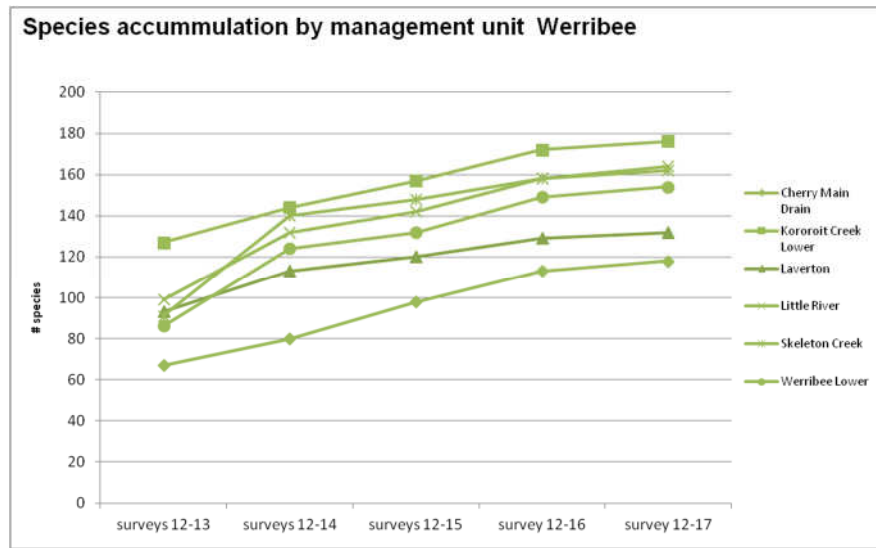
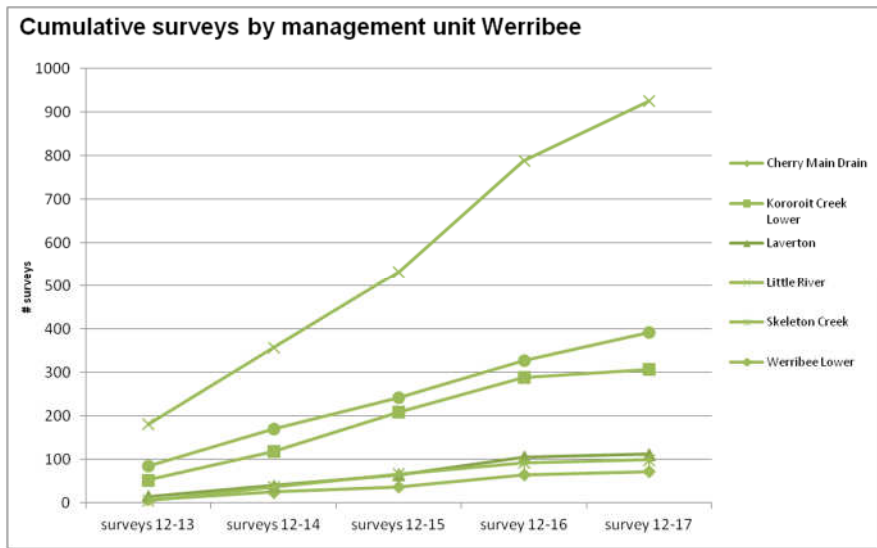


Figure 12a and b Survey effort and species accumulation across Werribee sub-catchment by management unit

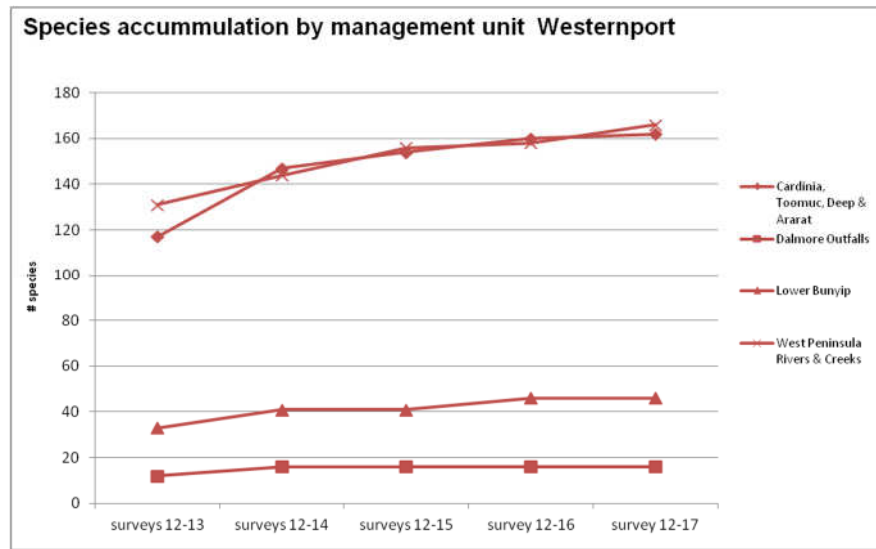
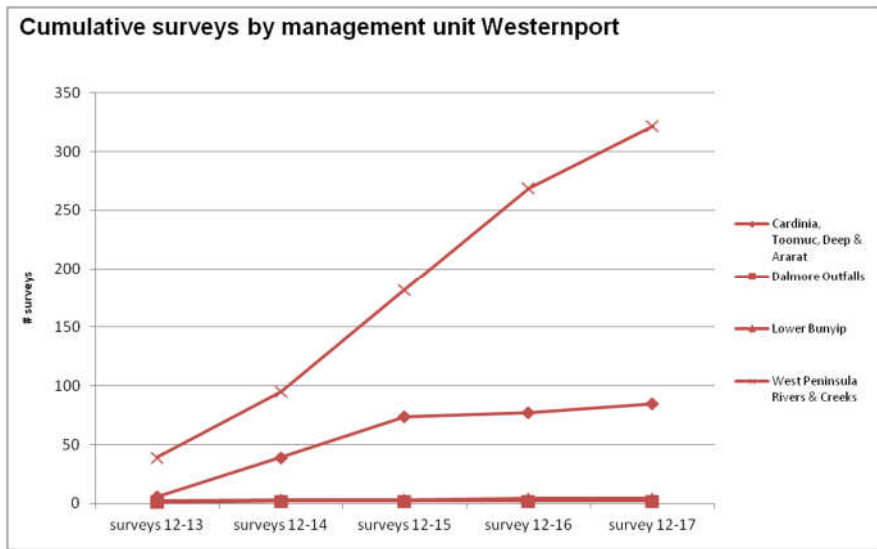
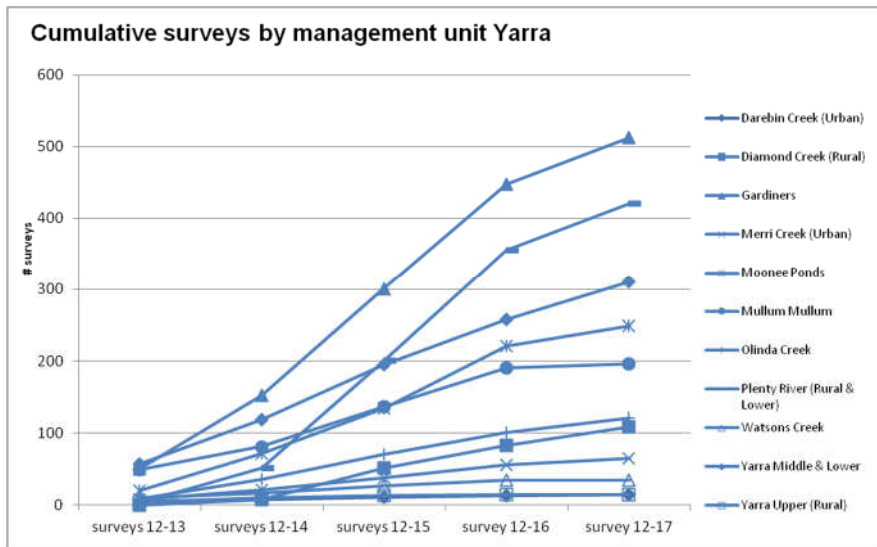
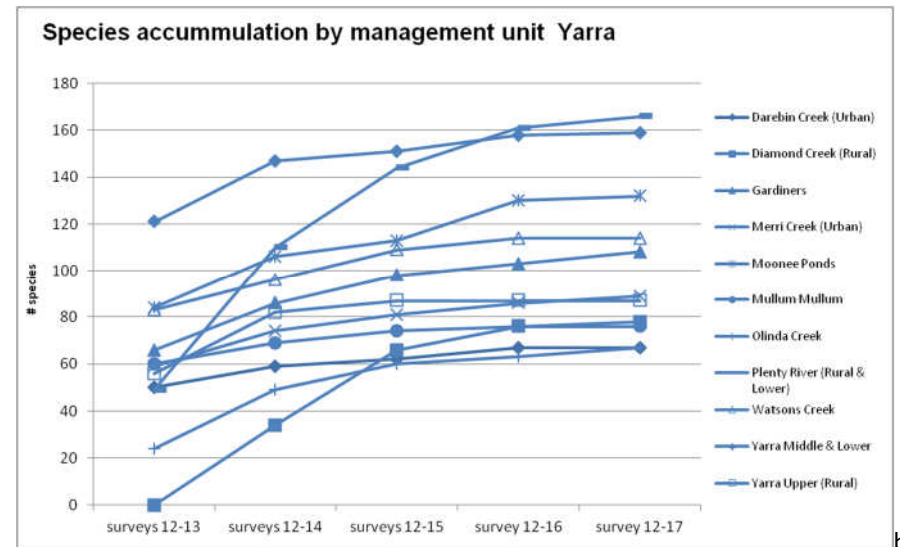


Figure 13a and b Survey effort and species accumulation across Westernport sub-catchment by management unit



a



b

Figure 14a and b Survey effort and species accumulation across Yarra sub-catchment by management unit

**Table 9 Survey summaries for targeted sites across the Dandenong Catchment throughout the project period.**

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Corhanwarrabul</b>												<b>182</b>
Birdsland, Monbulk Creek Retarding Basin	2	SoBS	1	38	11	82	24	94	36	99	48	101
Monbulk Creek Upstream Control	3	Works evaluation	0	0	3	32	18	50	36	58	51	60
Monbulk Creek Works Site	3	Works evaluation	0	0	3	27	14	42	19	43	26	44
Mulgrave Res wetland	4	Non MW	1	36	1	36	3	46	13	53	27	53
Rigby's Wetland Cell 1	5	MW constructed wetland	6	43	15	58	18	59	18	62	30	
Rigby's Wetland Cell 2	5	MW constructed wetland	7	52	16	68	20	69	20	69	34	100
Rigby's Wetland cell 3	5	MW constructed wetland	14	90	25	94	37	109	39		52	152
Rigby's Wetland cell 4	5	MW constructed wetland	7	57	17	67	20	76	20	76	32	106
Rigby's Wetland Miscellaneous	5	MW constructed wetland	0		0		52		158		209	
Waterford Wetlands,	5	MW constructed wetland	14	54	25	58	36	63	47	66	58	80
<b>Dandenong Creek Lower</b>												<b>185</b>
Braeside Park	1	Carrum KBA	38	94	86	101	104	104	105	105	108	105
Edithvale - Zone 1	1	Edithvale/Seaford Ramsar	13	43	25	62	36	74	49	80	62	81
Edithvale - Zone 2	1	Edithvale/Seaford Ramsar	15	100	34	113	60	130	87	132	125	135
Edithvale - Zone 3	1	Edithvale/Seaford Ramsar	13	44	25	50	36	56	48	60	60	61
Edithvale - Zone 4	1	Edithvale/Seaford Ramsar	13	28	25	34	36	36	48	38	60	40

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Edithvale - Zone 5	1	Edithvale/Seaford Ramsar	13	54	25	63	36	69	48	71	60	75
Edithvale - Zone 6	1	Edithvale/Seaford Ramsar	13	24	25	27	36	30	48	30	60	31
Edithvale - Zone 7	1	Edithvale/Seaford Ramsar	16	92	30	104	42	109	48	114	60	119
Edithvale - Zone 8	1	Edithvale/Seaford Ramsar	13	52	25	58	36	62	48	63	60	67
Wannarkladdin Wetlands - east	1	MW constructed wetland	3	52	11	67	23	74	34	77	42	76
Wannarkladdin Wetlands - north	1	MW constructed wetland	2	25	10	48	20	61	30	65	37	67
Wannarkladdin Wetlands - west	1	MW constructed wetland	2	45	13	79	25	86	34	92	42	93
Namatjira Wetlands, Clayton South	3	Works evaluation	6	44	23	63	35	68	64	71	79	71
Edithvale Common	4	Non MW	11	40	14	42	17	43	19	44	24	45
Elsternwick Park	4	Non MW	14	43	19	50	24	58	27	58	32	58
Karkarook Park	4	Non MW	27	92	155	120	272	130	517	142	747	144
Patterson River	4	Waterway	0	0	4	42	9	48	10	51	10	51
Springvale rd Wetlands	4	MW constructed wetland	19	90	52	99	141	111	195	114	261	117
Woodlands Estate Wetlands	4	MW constructed wetland	5	72	26	98	58	108	82	113	98	115
<b>Blind Creek</b>												<b>115</b>
Lakewood Park Res, Riddell Rd Retarding Basin	2	SoBS	3	49	12	69	32	77	50	83	70	83
Dandenong Wetlands, Koomba Park	4	Works evaluation	4	59	13	73	27	86	29	87	49	93

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Dandenong Creek Middle</b>												<b>163</b>
Colchester Road Retarding Basin,	2	SoBS	2	20	4	30	6	38	7	45	8	45
Fussel Road Retarding Basin	2	SoBS	2	25	5	47	7	54	9	60	10	62
Liverpool Road Retarding Basin	2	SoBS	10	73	18	81	21	83	65	109	78	109
Old Joes Creek Retarding Basin	2	SoBS	2	27	4	32	4	32	4	32	4	32
Police Rd retarding basin Wetland	2	SoBS	0	0	2	42	8	73	9	79	9	79
Tirhatuan Wetlands	2	SoBS	4	40	23	71	37	75	67	86	87	87
Winton Wetlands	2	SoBS	2	25	13	54	18	60	30	75	46	77
Heatherton Road North	5	MW constructed wetland	14	78	32	87	51	93	77	99	91	111
Heatherton Road South	5	MW constructed wetland	13	87	33	97	48	100	66	104	80	132
Jells Park Lake	4	Non MW	8	72	27	95	53	113	80	120	120	126
Koomba Park North	4	MW constructed wetland	1	13	7	58	14	71	20	74	34	78
<b>Eumemmerring</b>												<b>150</b>
Berwick Springs wetlands	4	Non MW	2	62	8	88	17	90	50	98	55	98
Frog Hollow Wetland	5	MW constructed wetland	15	67	27	70	39	73	51	84	64	101
Golf Links Road	5	MW constructed wetland	11	76	20	82	31	90	40	93	46	112
Hallam Valley Floodplain	5	MW constructed wetland	13	95	14	96	29	103	39	107	46	120
Hallam Valley Floodplain, Troups Creek	5	MW constructed wetland	15	97	27	100	39	103	51	106	64	117

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Kilberry Boulevard, Hampton Park East Drain	5	MW constructed wetland	12	74	24	81	35	85	46	89	61	99
River Gum Creek Reserve, Hamptn Park East Drain	5	MW constructed wetland	12	89	23	92	35	101	52	107	73	117
<b>Kananook</b>												<b>188</b>
Boundary Road Wetland, Eel Race Drain, ETP	1	Carrum KBA	16	104	38	114	75	122	100	127	124	130
Eastern Treatment Plant	1	Carrum KBA	11	127	26	133	41	144	52	145	65	151
ETP south, Serpentine area	1	Carrum KBA	0	0	7	54	17	80	17	80	28	99
PARCS Wetland, Eel Race Drain, ETP	1	Carrum KBA	2	47	11	69	21	77	32	87	34	90
Seaford Wetlands - Zone 1	1	Edithvale/Seaford Ramsar	15	97	43	121	59	131	82	138	101	141
Seaford Wetlands - Zone 2	1	Edithvale/Seaford Ramsar	12	39	24	43	35	45	48	47	60	53
Seaford Wetlands - Zone 3	1	Edithvale/Seaford Ramsar	12	55	24	64	35	70	48	75	60	82
Seaford Wetlands - Zone 4	1	Edithvale/Seaford Ramsar	12	60	24	73	35	79	48	84	60	90
Seaford Wetlands - Zone 5	1	Edithvale/Seaford Ramsar	12	58	24	67	35	74	48	79	60	83
Seaford Wetlands - Zone 6	1	Edithvale/Seaford Ramsar	12	34	24	44	36	61	49	66	61	68
The Doughnut, Eastern Treatment Plant	1	Carrum KBA	11	69	24	79	36	83	47	88	60	92
Boggy Creek Waterway Res, Boggy Creek	2	SoBS	1	18	3	42	3	42	3	42	3	42
Boggy Creek, Carrum	1	Devil Bend KBA	10	67	19	75	27	78	36	81	47	88
ETP Rossiter Rd Lagoon (Banyun)	2	Potential KBA inclusion	4	33	15	73	27	84	38	91	50	98
ETP turf farm	2	Potential KBA inclusion	4	49	14	71	24	88	35	97	42	105



site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Little Boggy Creek Retarding Basin	2	SoBS	1	13	3	39	3	39	3	39	3	39
Tamarisk Waterway Res, Langwarrin	2	SoBS	0	0	1	24	1	24	2	33	2	33

**Table 10. Survey summaries for targeted sites across the Maribyrnong Catchment throughout the project period.**

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Jacksons Creek</b>												<b>83</b>
Jacksons Creek Downstream Control	3	Works evaluation	0	0	5	26	18	34	33	47	38	47
Jacksons Creek Works Site	3	Works evaluation	0	0	5	40	18	52	34	60	39	60
Gisborne Swamp	4	Potential SOB	0	0	1	25	7	54	12	61	13	61
<b>Maribyrnong River</b>												<b>53</b>
Flemington Racecourse	4	Non MW	0	0	3	28	11	47	16	52	18	53
<b>Steele</b>												<b>44</b>
Valley Lake Reserve	4	Non MW	1	18	8	37	14	41	21	44	26	44

**Table 11. Survey summaries for targeted sites across the Werribee Catchment throughout the project period**

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Cherry Main Drain</b>												<b>118</b>
Cherry Lake, Cherry Creek	2	SoBS	7	66	16	79	26	96	52	113	68	118
Andersons lake	4	Non MW	0	1	9	0	11	12	13	20	13	20
<b>Kororoit Creek Lower</b>												<b>175</b>
Cherry Lake north, Big Bend	2	SoBS	0	0	1	30	5	39	17	64	23	67
Kororoit Creek Escarpments north	2	SoBS	2	31	3	35	4	35	5	40	5	40
Kororoit Creek Escarpments south	2	SoBS	2	33	3	37	4	37	5	46	5	46
Lower Kororoit Creek Waterway Res	2	SoBS	2	42	3	45	4	45	4	45	4	45
Jawbone Reserve, Williamstown	3	Works evaluation	33	99	78	119	150	129	196	142	230	144
Iramoo Wetlands	4	Non MW	0	0	2	40	6	53	12	59	15	59
Newport Lakes	4	Non MW	14	70	28	78	37	88	50	98	62	101
<b>Laverton</b>												<b>131</b>
Truganina Swamp, Laverton Creek	2	SoBS	15	90	40	111	63	118	102	129	161	131
Kayes Cr Waterway Res, Windsor Bvd	4	Waterway	0	0	0	0	1	7	2	9	3	13
Kayes Cr Waterway Res, Yeend Crt	4	Waterway	0	0	0	0	1	4	2	10	4	16
<b>Little River</b>												<b>160</b>
WTP - Little River, Lower Reaches	1	Pt Philip Bay W shore Ramsar	13	65	23	73	32	77	44	86	56	91

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
WTP – PondQ4	1	Pt Philip Bay W shore Ramsar	1	41	2	47	9	78	35	123	80	123
WTP - Summer Pond 1	1	Pt Philip Bay W shore Ramsar	6	34	17	61	26	67	38	76	44	78
WTP - Summer Pond 2	1	Pt Philip Bay W shore Ramsar	13	61	26	76	35	81	49	89	57	93
WTP - T Section Lagoon 1	1	Pt Philip Bay W shore Ramsar	12	25	22	33	33	38	44	46	52	46
WTP - T Section Lagoon 2	1	Pt Philip Bay W shore Ramsar	10	21	27	74	53	93	123	124	170	127
WTP - T Section Lagoon 3	1	Pt Philip Bay W shore Ramsar	25	53	45	96	62	109	73	112	83	113
WTP - T Section Lagoon 4	1	Pt Philip Bay W shore Ramsar	0	0	1	49	5	54	17	70	25	79
WTP - T Section Lagoon 5	1	Pt Philip Bay W shore Ramsar	13	40	24	51	33	55	44	63	52	70
WTP - T Section Lagoon 6	1	Pt Philip Bay W shore Ramsar	11	26	21	35	31	41	42	49	51	52
WTP - T Section Lagoon 7	1	Pt Philip Bay W shore Ramsar	12	46	23	53	34	59	48	77	57	79
WTP - Western Lagoon 3	1	Pt Philip Bay W shore Ramsar	3	21	12	35	21	38	30	44	38	47
WTP - Western Lagoon 6	1	Pt Philip Bay W shore Ramsar	12	19	22	32	32	36	41	45	49	47
WTP - Western Lagoon 7	1	Pt Philip Bay W shore Ramsar	12	29	23	36	32	38	38	41	46	43
WTP - Western Lagoon 8	1	Pt Philip Bay W shore Ramsar	13	32	23	41	32	41	40	48	47	49
WTP - Western Lagoon 9	1	Pt Philip Bay W shore Ramsar	13	59	24	65	31	65	39	70	47	72
WTP - Western Lagoon 4&5 rehab	1	Pt Philip Bay W shore Ramsar	12	49	23	54	32	57	44	73	52	75
<b>Skeleton Creek</b>												<b>162</b>
Cheetham Saltfields (Parks Victoria)	1	Pt Philip Bay W shore Ramsar	3	78	26	128	50	139	67	147	78	151

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Skeleton Creek Saltmarsh	2	SoBS	3	51	9	64	14	68	17	71	20	76
Williams Landing (Cedar Woods)	4	Non MW	0	0	2	38	3	42	9	64	9	64
<b>Werribee Lower</b>												<b>153</b>
RAAF Lake	1	Pt Philip Bay W shore Ramsar	0	0	12	73	26	82	40	93	49	97
WTP - 270S Borrow Pit	1	Pt Philip Bay W shore Ramsar	15	68	25	76	35	90	45	95	57	98
WTP - 35E Pond 8 Conservation Pond	1	Pt Philip Bay W shore Ramsar	13	43	23	52	31	55	41	94	49	94
WTP - 35E Pond 9 Conservation Pond	1	Pt Philip Bay W shore Ramsar	12	46	22	55	28	59	34	62	42	67
WTP - 5W Pond 10	1	Pt Philip Bay W shore Ramsar	10	26	20	42	27	45	38	50	46	51
WTP - 5W Pond 11	1	Pt Philip Bay W shore Ramsar	11	27	21	40	27	44	38	51	46	55
WTP - 5W Pond 9	1	Pt Philip Bay W shore Ramsar	10	34	20	47	28	53	39	55	47	55
WTP - 85WC Pond 9	1	Pt Philip Bay W shore Ramsar	14	39	24	44	33	46	44	49	54	56
Werribee River Downstream Control	3	Works evaluation	0	0	2	25	4	32	4	32	5	36
Werribee River Works Site	3	Works evaluation	0	0	2	30	4	38	4	38	5	39
Cunningham Swamp North	4	Natural ephemeral	0	0	0	0	0	0	0	0	1	18
Cunningham Swamp South	4	Natural ephemeral	0	0	0	0	0	0	0	0	1	17

**Table 12. Survey summaries for targeted sites across the Westernport Catchment throughout the project period**

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Cardinia, Toomuc, Deep &amp; Ararat</b>												<b>161</b>
Cardinia Creek Retarding Basin	2	SoBS	1	25	1	25	1	25	2	32	2	32
The Inlets Waterway Res, Cardinia	2	SoBS	3	52	12	77	23	96	22	111	30	114
Cardinia Reservoir (7 sites)	2	SoBS	2	58	26	103	50	106	53	121	55	121
<b>Dalmore Outfalls</b>												<b>15</b>
Leisureland Drive drain	4	Waterway	1	11	2	15	2	15	2	15	2	15
<b>Lower Bunyip</b>												<b>46</b>
Koo Wee Rup Tower	4	Waterway	2	32	3	40	3	40	4	46	4	46
<b>West Peninsula Rivers &amp; Creeks</b>												<b>165</b>
Bittern Reservoir	1	Devilbend KBA (PV)	0	0	0	0	2	41	3	50	12	84
Devilbend Reservoir	1	Devilbend KBA (PV)	12	107	18	108	26	115	29	118	41	118
Briars central tributary	3	Works evaluation	0	0	1	8	2	13	2	13	2	13
Briars eastern tributary	3	Works evaluation	0	0	1	7	2	11	2	11	2	11
Briars western tributary	3	Works evaluation	0	0	1	7	2	10	2	10	2	10
Industrial Estate Retarding Basin	4	MW retarding basin	0	0	3	19	5	27	9	46	9	46
MPS Tootgarook Wetland Reserve boundary	4	Non MW	0	0	2	41	4	55	8	65	8	65
Sanctuary Park Reserve	4	Non MW	0	0	4	50	19	84	28	91	36	98

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Tern Ave Wetland	4	Non MW	0	0	3	35	7	52	13	54	14	54
Tootgarook swamp - A McNaughts lake	4	Non MW	2	43	6	64	9	71	15	76	17	79
Tootgarook swamp - C Moona swamp	4	Non MW	2	14	3	18	3	18	5	22	5	22
Tootgarook swamp - D Moona swamp 2	4	Non MW	2	12	4	21	7	32	10	36	10	36
Tootgarook Swamp 92W	4	Non MW	0	0	4	25	17	53	25	60	35	70
Tootgarook Swamp, McNaught accumulative	4	Non MW	2	39	6	61	10	69	15	80	16	80
Tootgarook swamp - B Gahnia swamp	4	Non MW	2	21	6	47	10	53	15	62	15	62
Truemans Rd landfill	4	Non MW	0	0	4	30	15	59	24	65	28	70
Woods Reserve	4	Non MW	17	82	29	86	42	92	64	94	86	98

**Table 13. Survey summaries for targeted sites across the Yarra Catchment throughout the project period**

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Darebin Creek (Urban)</b>												<b>67</b>
Darebin Parklands	4	Non MW	5	49	8	58	11	61	13	67	15	67
<b>Diamond Creek (Rural)</b>												<b>77</b>
Works evaluation - site 13	3	Works evaluation	0	0	2	19	14	42	24	48	32	53
Works evaluation - site 14	3	Works evaluation	0	0	2	14	14	31	24	45	32	49
Works evaluation - site 15	3	Works evaluation	0	0	3	22	19	48	26	48	33	52
Works evaluation – site 16	3	Works evaluation	0	0	1	20	4	41	9	47	11	39
<b>Gardiners</b>												<b>102</b>
Valley Reserve Retarding Basin, Mount Waverley	4	MW retarding basin	0	0	5	29	14	41	45	52	94	55
Wurundjeri Walk, Blackburn South	4	Waterway	34	53	68	63	116	69	154	72	188	79
Ashwood – Queens Parade	4	Waterway	0	0	0	0	0	0	3	24	6	24
Gardiners Creek – Station St to Burwood Highway	4	Waterway	1	10	7	30	18	39	28	44	64	50
Huntingdale Wetlands	4	Waterway	15	55	65	76	130	87	190	90	337	90
Jingella Park – Gardiners Creek	4	Waterway	0	0	7	41	23	46	27	47	32	47
<b>Merri Creek (Urban)</b>												<b>69</b>
Galada Tamboore South, Merri Creek	2	SoBS	4	44	7	50	12	55	17	62	24	62
Lakeside Drive Reserve	4	Non MW	2	19	7	32	11	35	16	42	19	44



site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Moir Drive Reserve	4	Non MW	0	0	2	22	6	41	10	46	13	50
Wintersun Crt Reserve	4	Non MW	2	18	5	31	9	37	13	42	16	47
<b>Moonee Ponds</b>												<b>131</b>
Wright Street Retarding Basin	2	SoBS	4	40	11	60	17	62	24	72	30	74
Jacana Wetlands (south)	4	MW constructed wetland	4	33	6	41	11	46	15	47	18	50
Jacana Wetlands (north)	4	MW constructed wetland	8	68	16	77	27	82	41	96	51	98
Moonee Ponds Creek, Westmeadows	4	Waterway	1	14	4	22	9	34	12	41	15	41
Trin Warren Tam-boore Wetlands	4	MW constructed wetland	1	19	20	68	46	84	93	98	155	99
Westbreen Creek - Gavin Park	4	Non MW	1	6	4	21	6	26	11	31	13	32
Westbreen Creek - Joyce Reserve	4	Non MW	1	7	4	16	6	21	9	24	12	26
Woodlands Park, Essendon	4	Non MW	0	0	6	32	12	38	16	38	20	40
<b>Mullum Mullum</b>												<b>76</b>
Mullum Mullum Creek Currawong Park	3	Works evaluation	0	0	15	42	58	52	98	55	138	55
Mullum Mullum Park	4	Waterway	37	43	46	45	50	61	50	61	52	61
Yarran Dheran Reserve	4	Non MW	12	43	20	50	29	52	42	54	44	54
<b>Olinda Creek</b>												<b>66</b>
Silvan Reservoir Park	2	SoBS	5	65	6	77	12	85	15	85	20	87
Olinda Creek, control	3	Works evaluation	0	0	8	29	17	35	27	38	32	38

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Olinda Creek, Staged removal	3	Works evaluation	2	16	11	33	20	40	29	45	35	48
Olinda Creek, Willow removed	3	Works evaluation	2	16	11	41	21	50	30	53	34	57
<b>Plenty River (Rural &amp; Lower)</b>												<b>125</b>
Dunnetts Road Swamp, Plenty River	2	SoBS	2	25	4	47	7	54	10	62	10	62
Yan Yean Reservoir Park	2	MW reservoir	1	35	3	58	20	96	67	127	71	127
works evaluation - site 1	3	Works evaluation	0	0	2	23	13	41	23	44	23	44
works evaluation - site 10	3	Works evaluation	0	0	1	7	13	43	23	53	28	56
works evaluation - site 2	3	Works evaluation	0	0	2	26	14	59	25	68	25	68
works evaluation - site 3	3	Works evaluation	0	0	2	22	12	51	19	58	19	58
works evaluation - site 4	3	Works evaluation	0	0	0	0	1	12	1	12	1	13
works evaluation - site 5	3	Works evaluation	0	0	2	14	14	42	24	51	32	64
works evaluation - site 6	3	Works evaluation	0	0	2	19	13	46	23	53	31	57
works evaluation - site 7	3	Works evaluation	0	0	2	25	14	68	24	72	32	73
works evaluation - site 8	3	Works evaluation	0	0	1	10	13	51	23	57	31	61
works evaluation - site 9	3	Works evaluation	0	0	3	20	15	48	25	57	33	62
PG- Marshland/Carex/ Tortoise Pond	4	Non MW	0	0	8	67	16	78	21	83	28	87
PG- Mother in Law's Leap	4	Non MW	0	0	9	56	17	63	23	75	30	83
PG- North East Wetland	4	Non MW	0	0	10	71	19	83	24	92	30	97

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
<b>Watsons Creek</b>												<b>113</b>
A Track- BICA	4	Waterway	2	32	4	42	5	42	5	42	5	57
B track- BICA	4	Waterway	1	28	1	28	1	28	1	28	1	29
C track- BICA	4	Waterway	2	48	3	52	4	54	5	59	5	59
Powerline Easement- BICA	4	Waterway	1	20	1	20	2	41	5	51	6	51
Proper-Yanakie- BICA	4	Waterway	0	0	0	0	1	43	1	43	1	43
Watsons Creek N of Bridge- BICA	4	Waterway	4	78	8	92	14	104	17	107	17	107
<b>Yarra Middle &amp; Lower</b>												<b>158</b>
Andersons Creek East Retarding Basin	2	SoBS	0	0	4	37	6	45	6	45	7	46
Bolin Bolin Billabong	3	Works evaluation	21	71	30	75	44	79	50	83	53	83
Salt Creek, Rosanna Parklands	3	Works evaluation	3	16	13	35	25	35	32	37	48	38
Duff's to Gully	4	Waterway	2	39	3	50	3	50	3	50	3	51
Gongflers Peninsula	4	Waterway	0	0	1	43	1	43	2	50	2	50
Henley Rd, East	4	Waterway	1	45	3	68	3	68	3	68	3	69
Market Garden Bend	4	Waterway	2	41	2	41	2	41	7	69	7	69
Murunduka Swamp	4	PV significant site	0	0	6	71	20	86	26	88	30	91
Ruffey Lake Park	4	Non MW	3	59	9	71	19	73	34	79	62	81
Westgate Park	4	Non MW	25	70	44	75	65	82	87	93	104	95

site name	category	significance	surveys 12-13	species 12-13	surveys 12-14	species 12-14	surveys 12-15	species 12-15	survey 12-16	species 12-16	survey 12-17	species 12-17
Yaruk Tamboore	4	Non MW	0	0	4	39	7	45	8	47	13	56
<b>Yarra Upper (Rural)</b>												<b>86</b>
Yering Backswamp	2	SoBS	4	55	10	81	13	86	14	87	14	87

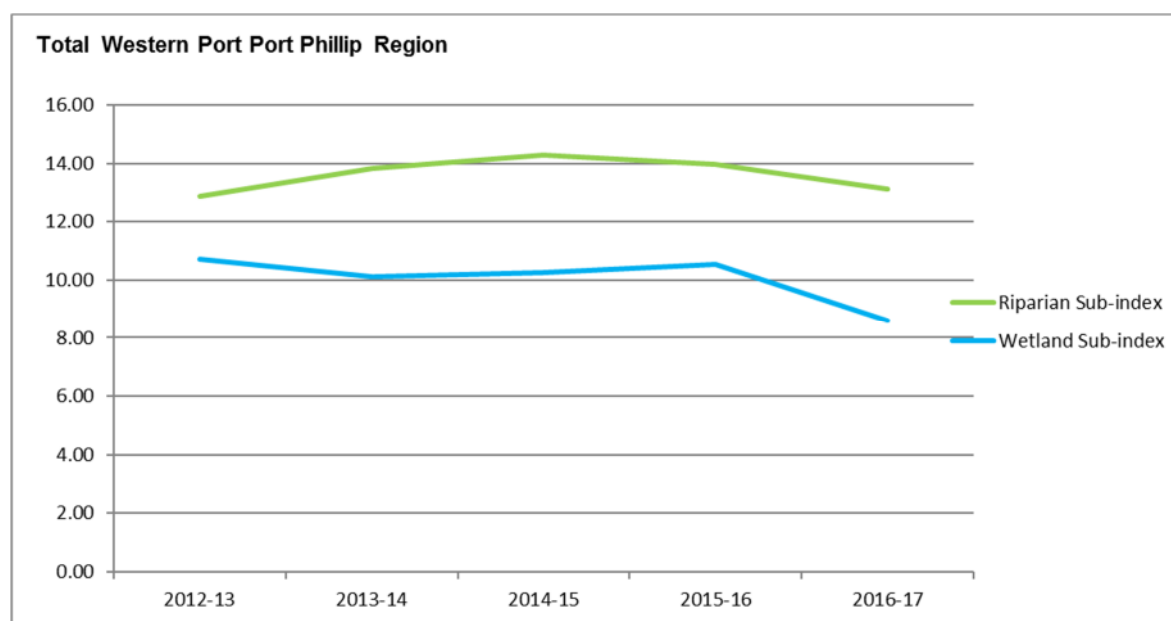
## Avian Sub-index

The avian sub-index was developed as a way of measuring change in ecosystem condition over time (Steele 2011). Table 14 presents the calculated sub-index score for riparian and wetland birds at catchment scale calculated from the data collected across the sites included in the MWRbm project.

**Table 14 calculated avian sub-indices across project period**

	Riparian Sub-index					Wetland Sub-index				
	2012-13	2013-14	2014-15	2015-16	2016-17	2012-13	2013-14	2014-15	2015-16	2016-17
Dandenong	15.40	15.74	17.10	16.73	16.19	13.33	12.49	13.32	12.70	9.48
Maribyrnong			12.02	11.13	11.67			4.81	4.11	2.44
Werribee	5.65	6.96	7.70	8.00	7.52	10.58	11.19	12.23	12.73	8.50
Westernport	20.52	17.99	15.05	15.39	16.53	5.57	4.19	6.69	5.63	7.53
Yarra	15.39	15.36	14.09	14.10	12.34	6.08	5.77	5.00	5.88	5.62
<b>Total</b>	<b>12.88</b>	<b>13.84</b>	<b>14.28</b>	<b>13.99</b>	<b>13.12</b>	<b>10.71</b>	<b>10.10</b>	<b>10.25</b>	<b>10.55</b>	<b>8.10</b>

Generally the two sub indices have remained fairly stable between years across the Westernport Port Phillip Catchment area. However we see a sharp decline in the wetland sub-index in the 2016-17 survey period. (Figure 15).



**Figure 15 Total calculated sub-indices for Westernport Port Phillip catchment**

### Sub-indices across Catchments

Looking at the five catchments we see that there is quite a bit of variation in the sub-indices between them. For riparian species Westernport recorded a much higher score at the beginning of the monitoring project and has gradually declined to be on par with Dandenong (which has remained fairly stable over the five years). Werribee has shown a slight increase, starting from a significantly lower point than the other catchments. This is not surprising considering few sites within this catchment support appropriate riparian habitat for the birds that make up the sub index. Yarra shows a slight decline in score.

Wetland scores are also quite variable between sub-catchments. Westernport has generally tracked upwards over the five year period and is the only catchment to see an increase in the 2016-17 surveys. Yarra has remained stable, but both Dandenong and Werribee show steep declines in the 5<sup>th</sup> survey year. This decline corresponds to observed changes in the birds on site during surveys. Surveyors reported a lack of many

wetland species, believed to have moved further inland in response to extensive rainfall (C. Purnell per com. Figure 18)

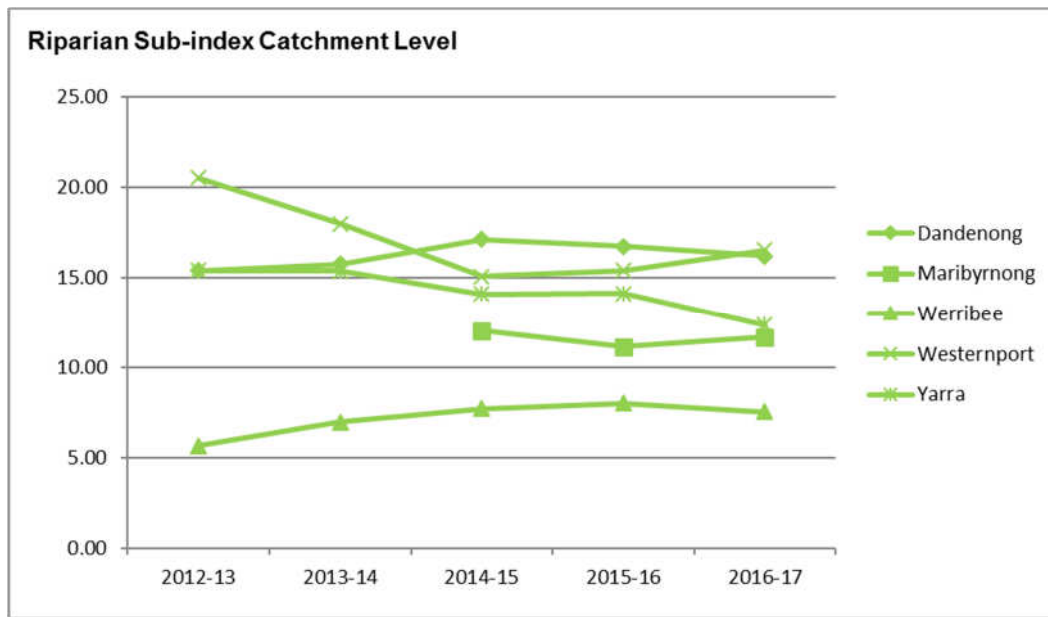


Figure 16 Riparian bird sub-index across sub-catchments

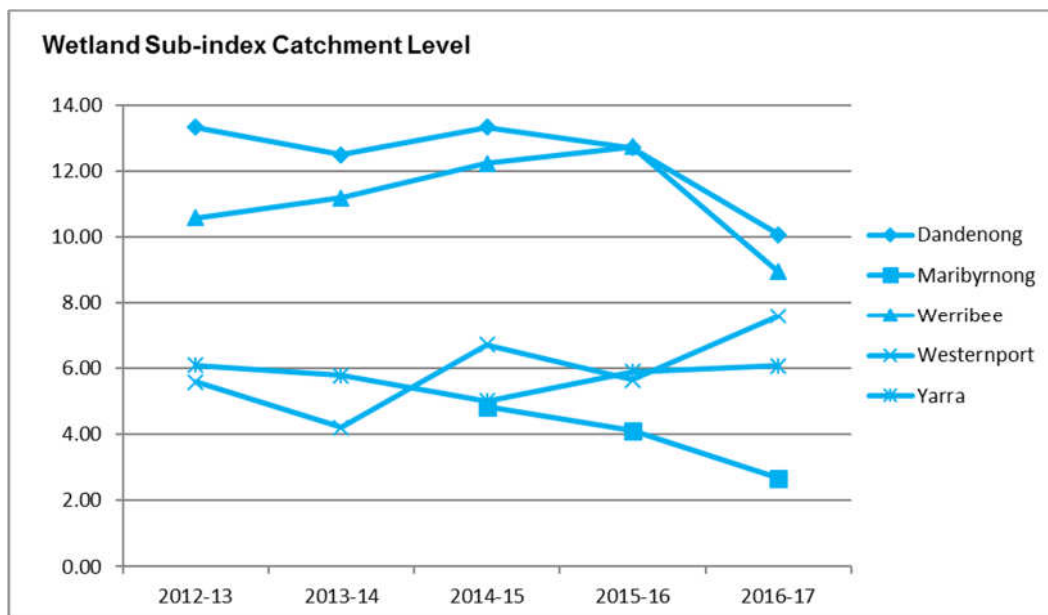
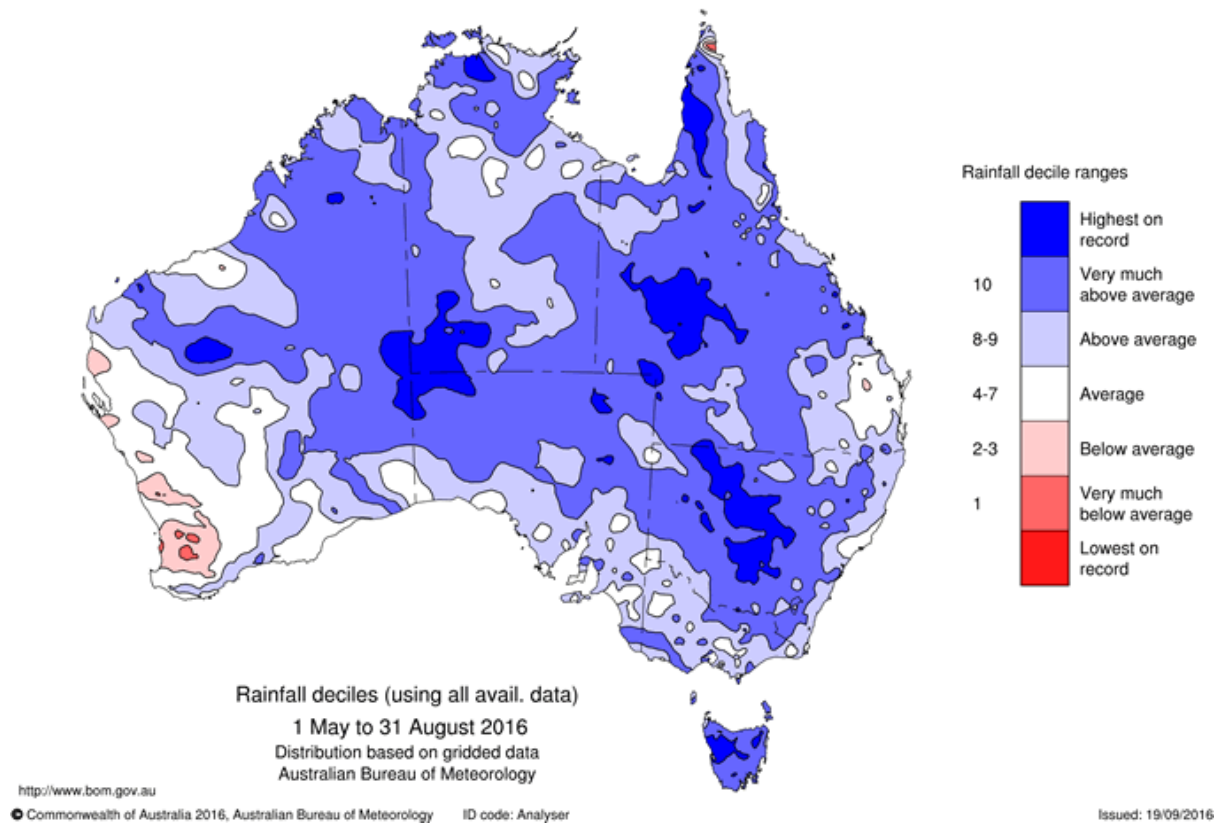


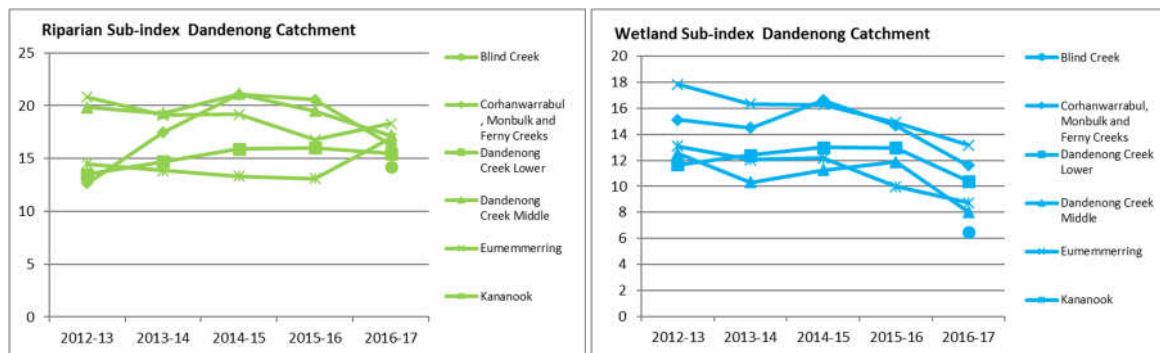
Figure 17 Wetland bird sub-index across sub-catchments



**Figure 18 Rainfall map of Australia showing high inland rainfall (May – August 2016). Figure sourced from the Australian Bureau of Meteorology. www.bom.gov.au**

**Sub-indices across Management Area**

Sub-indices were calculated for those management units which met the criteria of >40 surveys having been undertaken during the survey period. Generally the riparian index was found to be higher than the wetland index, however this was not the case across the Werribee catchment. This reflects the spread of survey sites, with the majority of sites in this catchment located within the Western Treatment Plant. These differences highlight why indices like this are only appropriate to track temporal changes across management units, and not compare between units; you do not compare like with like. Figures 19-22 present the calculated sub-indices for each management unit. There is insufficient survey effort across Maribyrnong to allow for the calculation of sub-indices for management units in this catchment.



**Figure 19a and b Sub-indices calculated for management units across the Dandenong sub-catchment**



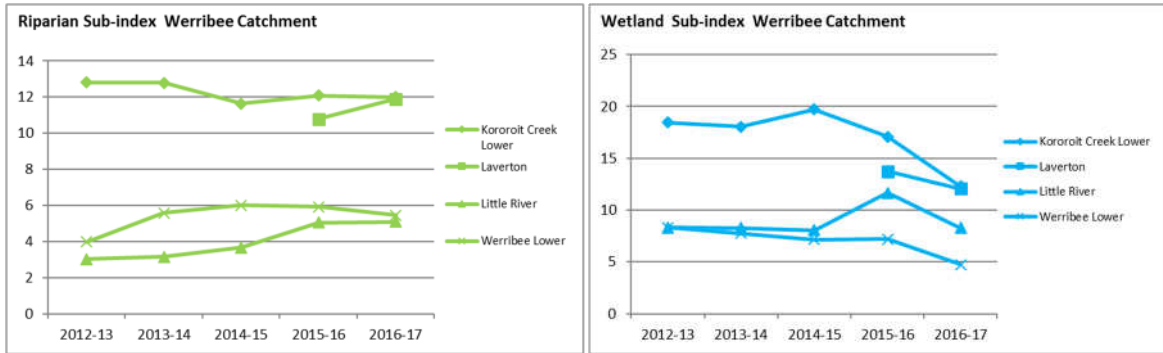


Figure 20a and b Sub-indices calculated for management units across the Werribee sub-catchment

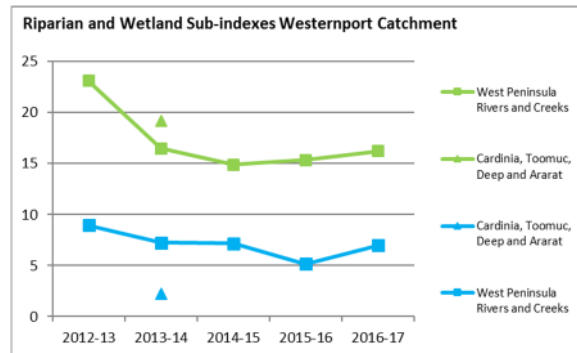


Figure 21 Sub-indices calculated across the Westernport sub-catchment

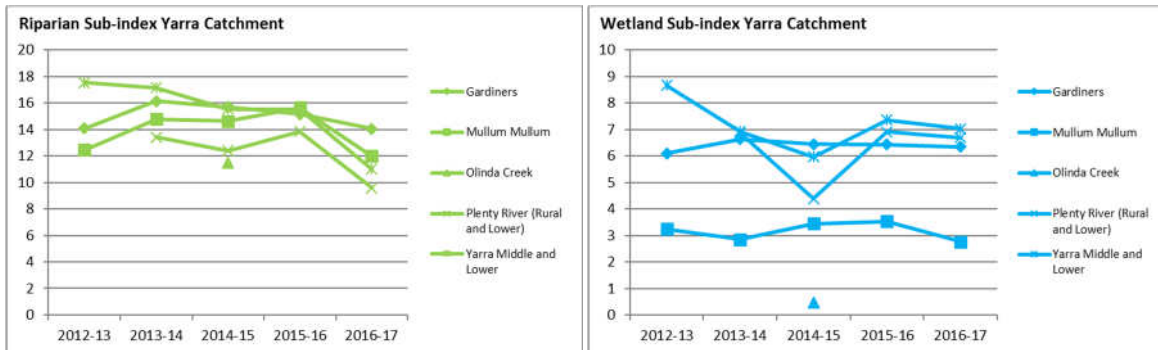


Figure 22a and b Sub-indices calculated for management units across the Yarra sub-catchment. Insufficient survey effort for Olinda Creek in all survey periods except 2014-15.

**Table 15 Sub-indices for management areas. Where survey effort was insufficient to allow calculation of sub-index (survey effort <40) values have been left blank.**

	Riparian Sub-index					Wetland Sub-index				
	2012-13	2013-14	2014-15	2015-16	2016-17	2012-13	2013-14	2014-15	2015-16	2016-17
Blind Creek					14.20					6.45
Cardinia, Toomuc, Deep and Ararat		19.21					2.24			11.30
Cherry Main Drain										14.06
Corhanwarrabul, Monbulk and Ferny Creeks	12.68	17.47	21.06	20.58	16.25	15.12	14.51	16.63	14.67	11.61
Dalmore Outfalls										
Dandenong Creek Lower	13.49	14.69	15.89	16.00	15.46	11.67	12.39	12.99	12.97	10.40
Dandenong Creek Middle	19.83	19.29	21.09	19.49	17.16	12.52	10.30	11.25	11.86	8.03
Darebin Creek (Urban)										
Diamond Creek (Rural)			8.44					0.41		
Eumemmerring	20.82	19.09	19.16	16.79	18.29	17.83	16.33	16.27	14.91	13.16
Gardiners	14.08	16.13	15.70	15.14	14.03	6.10	6.64	6.45	6.43	6.35
Jacksons Creek										
Kananook	14.49	13.87	13.32	13.10	16.93	13.09	12.05	12.15	9.98	8.73
Kororoit Creek Lower	12.82	12.79	11.65	12.09	12.00	18.45	18.03	19.70	17.08	12.28
Laverton				10.79	11.90				13.72	12.05
Little River	3.02	3.15	3.66	5.06	5.09	8.30	8.28	8.05	11.65	8.28
Lower Bunyip										
Maribyngong River										
Merri Creek (Urban)										
Moonee Ponds		13.02	13.78	13.56	13.58		7.27	8.63	7.63	7.91
Mullum Mullum	12.46	14.76	14.62	15.65	12.00	3.25	2.85	3.45	3.54	2.77
Olinda Creek			11.49					0.46		
Plenty River (Rural and Lower)		13.42	12.40	13.85	9.58		6.85	4.39	6.91	6.70
Skeleton Creek										
Steele										
Watsons Creek										
Werribee Lower	3.98	5.58	6.00	5.93	5.46	8.33	7.76	7.17	7.18	4.73
West Peninsula Rivers and Creeks	23.10	16.48	14.88	15.33	16.20	8.95	7.25	7.18	5.16	7.03
Yarra Middle and Lower	17.52	17.16	15.53	15.52	11.00	8.67	6.94	5.98	7.36	5.53
Yarra Upper (Rural)										

### *Sub-indices across Sites*

The criteria of >40 surveys limits the number of sites that sub-indices can be calculated. It also limits the temporal scale at which calculation can be undertaken. To enable some index calculation all survey data (5 years) was pooled to allow for the calculation of a single index at this point in time. For this to be useful it is suggested that future calculation be undertaken on a rolling system – that is next year an index calculation for the five year period 2013-14 to 2017-18 be used and compared back to the current index. Of the 235 sites 93 were found to have sufficient survey effort (>40 surveys) over the five year period to allow for the calculation of indices. These are presented in Table 16.

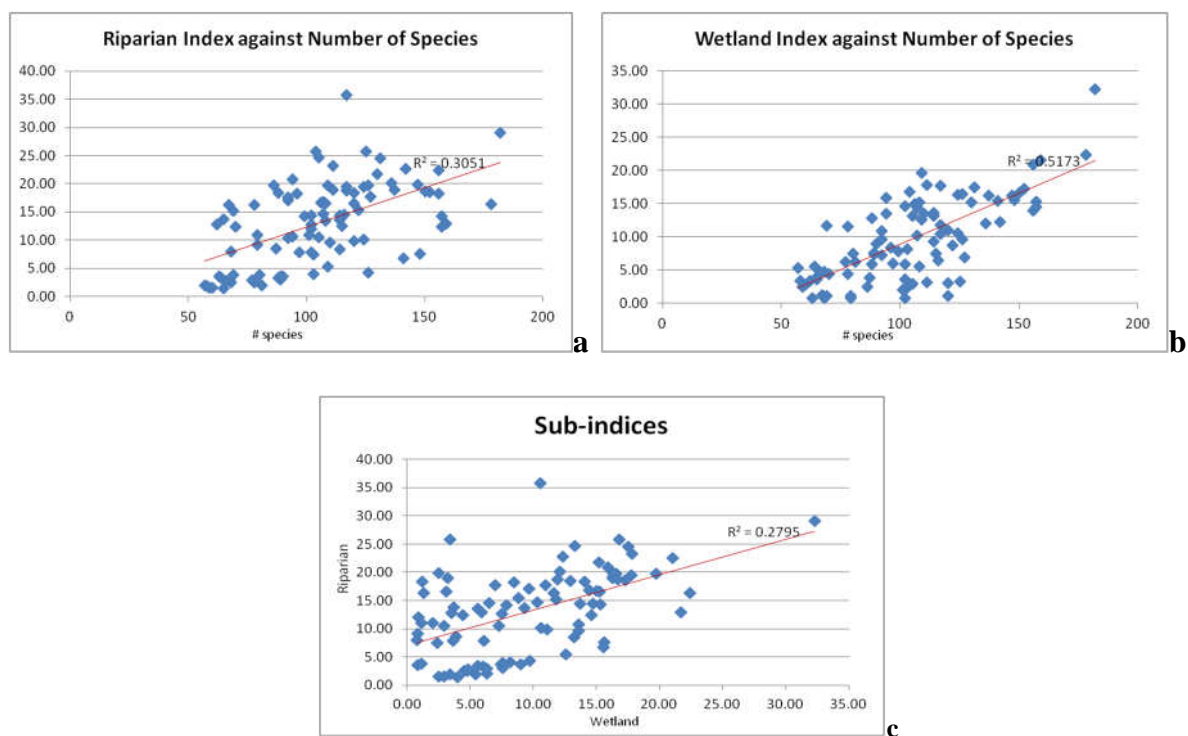
**Table 16. Calculated sub-indices for Riparian and Wetland birds. Numbers in *bold* are the maxima for each of the index calculated.**

Sub-catchment	Management Unit	Site	Number of surveys	Number of species	Riparian Index	Wetland Index	
Dandenong	Blind Creek	Dandenong Wetlands, Koomba Park	49	127	17.71	6.96	
		Lakewood Park Res, Riddell Road Retarding Basin	70	92	17.11	9.66	
	Corhanwarrabul, Monbulk and Ferny Creeks	Birdsland, Monbulk Creek Retarding Basin	48	117	<b>35.81</b>	10.54	
		Monbulk Creek Upstream Control	51	102	11.96	0.88	
		Rigby's Wetland cell 3	275	156	22.50	21.01	
		Waterford Wetlands, aka Karoo Road Wetland	58	69	15.19	11.79	
		Dandenong Creek Lower	Braeside Park	108	108	16.52	15.28
		Edithvale - Zone 1	68	103	7.47	2.41	
		Edithvale - Zone 2	125	152	18.58	17.31	
		Edithvale - Zone 3	60	101	10.97	2.07	
	Dandenong Creek Lower	Edithvale - Zone 4	60	63	3.58	0.83	
		Edithvale - Zone 5	60	97	7.87	6.08	
		Edithvale - Zone 6	60	69	3.83	1.13	
		Edithvale - Zone 7	66	137	18.94	16.26	
		Edithvale - Zone 8	60	87	8.55	3.90	
		Karkarook Park	<b>747</b>	156	18.33	14.07	
		Namatjira Wetlands, Clayton South	108	78	16.31	11.65	
		Springvale rd Wetlands, Mordialloc Creek	261	124	19.48	16.39	
		Wannarkladdin Wetlands - east	42	92	10.45	7.29	
		Wannarkladdin Wetlands - west	41	106	16.76	15.00	
	Dandenong Creek Middle	Woodlands Estate Wetlands	98	126	19.76	16.56	
		Heatherton Road North	79	104	25.82	16.84	
		Heatherton Road South	67	105	24.70	13.27	
		Jells Park Lake	119	142	22.74	12.35	
		Liverpool Road Retarding Basin, Dandenong Creek	78	117	18.77	11.91	
		Tirhatuan Wetlands, Dandenong Creek	87	99	14.23	7.87	
		Winton Wetlands	46	102	12.85	5.91	
		Eumemmerring	Berwick Springs wetlands	55	102	14.36	14.71
		Frog Hollow Wetland, Eumemmerring Creek	64	88	18.48	12.94	
		Golf Links Road	48	94	20.83	15.92	
	Eumemmerring	Hallam Valley Floodplain	45	111	23.29	17.84	
		Hallam Valley Floodplain, Troups Creek	64	109	19.73	19.72	
		Kilberry Boulevard, Hampton Park East Drain	60	92	17.65	10.98	
		River Gum Creek Reserve, Hampton Park East Drain	72	117	19.46	17.79	
		Kananook	Boggy Creek, Carrum	47	94	10.74	13.60
		Boundary Road Wetland, Eel Race Drain, ETP	124	157	14.28	15.34	
	Kananook	Eastern Treatment Plant	65	<b>182</b>	29.14	<b>32.28</b>	
		ETP Rossiter Rd Lagoon (beside Banyun)	50	110	9.66	13.62	

Sub-catchment	Management Unit	Site	Number of surveys	Number of species	Riparian Index	Wetland Index
		ETP turf farm	42	120	9.88	11.07
		Seaford Wetlands - Zone 1	101	150	18.68	16.69
		Seaford Wetlands - Zone 2	60	79	10.97	1.15
		Seaford Wetlands - Zone 3	61	120	16.56	3.08
		Seaford Wetlands - Zone 4	60	102	7.85	3.67
		Seaford Wetlands - Zone 5	60	111	18.97	3.20
		Seaford Wetlands - Zone 6	61	79	9.15	0.84
		The Doughnut, Eastern Treatment Plant	60	114	13.67	9.32
<b>Werribee</b>	<b>Cherry Main Drain</b>	Cherry Lake, Cherry Creek	68	147	19.88	16.32
	<b>Kororoit Creek Lower</b>	Jawbone Reserve, Williamstown	232	159	12.90	21.69
		Newport Lakes	62	107	14.73	10.29
	<b>Laverton</b>	Truganina Swamp, Laverton Creek	161	157	12.43	14.63
	<b>Little River</b>	WTP - Little River, Lower Reaches	59	114	8.46	13.22
		WTP - Pond Q4	82	148	7.65	15.63
		WTP - Summer Pond 1	48	89	3.67	7.48
		WTP - Summer Pond 2	60	109	5.40	12.60
		WTP - T Section Lagoon 1	56	57	1.96	5.41
		WTP - T Section Lagoon 2	174	141	6.75	15.55
		WTP - T Section Lagoon 3	87	126	4.30	9.70
		WTP - T Section Lagoon 5	57	81	2.02	6.30
		WTP - T Section Lagoon 6	55	65	1.44	4.02
		WTP - T Section Lagoon 7	61	89	3.08	7.61
		WTP - Western Lagoon 3	43	78	2.56	4.51
		WTP - Western Lagoon 6	51	59	1.57	2.53
		WTP - Western Lagoon 7	50	58	1.90	3.40
		WTP - Western Lagoon 8	51	60	1.55	2.92
		WTP - Western Lagoon 9	51	88	3.27	6.00
		WTP - Western Lagoon Ponds 4&5 (rehab)	56	90	3.66	9.04
	<b>Skeleton Creek</b>	Cheetham Saltfields (Parks Victoria)	78	178	16.37	22.38
	<b>Werribee Lower</b>	RAAF Lake	48	115	12.60	7.54
		WTP - 270S Borrow Pit	61	124	10.16	10.59
		WTP - 35E Pond 8 Conservation Pond	54	103	4.04	8.17
		WTP - 35E Pond 9 Conservation Pond	47	80	3.87	7.55
		WTP - 5W Pond 10	49	64	3.37	5.61
		WTP - 5W Pond 11	50	68	2.50	4.78
		WTP - 5W Pond 9	50	66	2.84	4.84
		WTP - 85WC Pond 9	58	77	2.97	6.31
<b>Westernport</b>	<b>Cardinia, Toomuc, Deep and Ararat</b>	Cardinia Reservoir	135	120	18.39	1.21
<b>Westernport</b>		The Inlets Waterway Reserve, Cardinia	41	136	20.10	12.12
<b>Westernport</b>	<b>West Peninsula Rivers and Creeks</b>	Devilbend Reservoir	41	130	21.80	15.22
<b>Westernport</b>		Woods Reserve	86	125	25.76	3.38

Sub-catchment	Management Unit	Site	Number of surveys	Number of species	Riparian Index	Wetland Index
Yarra	Gardiners	Gardiners Ck - Station St to Burwood Hwy	64	105	10.55	2.95
		Huntingdale Wetlands	337	96	18.24	8.50
		Valley Reserve retarding Basin, Waverly	94	70	12.38	4.41
		Wurundjeri Walk, Blackburn South	188	108	13.54	5.61
	Moonee Ponds	Jacana Wetlands (north)	51	107	16.82	14.43
		Trin Warren Tam-boore wetlands	155	122	15.39	8.83
	Mullum Mullum	Mullum Mullum Creek Currawong Park	138	65	13.81	3.72
		Mullum Mullum Park	52	62	12.83	3.50
		Yarran Dheran Reserve	44	67	16.32	1.30
	Plenty River (Rural and Lower)	Yan Yean Reservoir Park	71	131	24.52	17.55
	Yarra Middle and Lower	Bolin Bolin Billabong	53	86	19.83	2.51
		Ruffey Lake Park	62	116	14.52	6.48
		Salt Creek, Rosanna Parklands	48	68	8.00	0.79
		Westgate Park	104	114	14.43	13.72

Exploratory analyses were undertaken to determine the relationship between the sub-indices and species diversity; how representative of the actual diversity of a site are the calculated indices? Are these appropriate in assessing the overall condition of a site? Exploration was also undertaken to determine if there is a relationship between the two sub-indices and recorded species numbers. Figures 23a-c show scatter plots of the relationships between the riparian and wetland sub-indices and species number. It is assumed that all expected species have effectively been recorded for each site (>40 surveys as determined by AECOMM 2011).



**Figure 23a-c Scatter plots of relationship between the calculated sub-indices and the number of species recorded across each of the 93 sites survey in the MWrbm project with sufficient survey effort over the 5 year monitoring period.**

Spearman's Rank Order Correlation (non-parametric test) was used to determine the significance of these relationships. All three relationships were found to be highly statistically significant, however the strength of the correlation was variable. Table 17 provides the results of this test.

**Table 17 Results of Spearman Rank Order Correlation between Riparian sub-index, wetland sub-index and bird species diversity.**

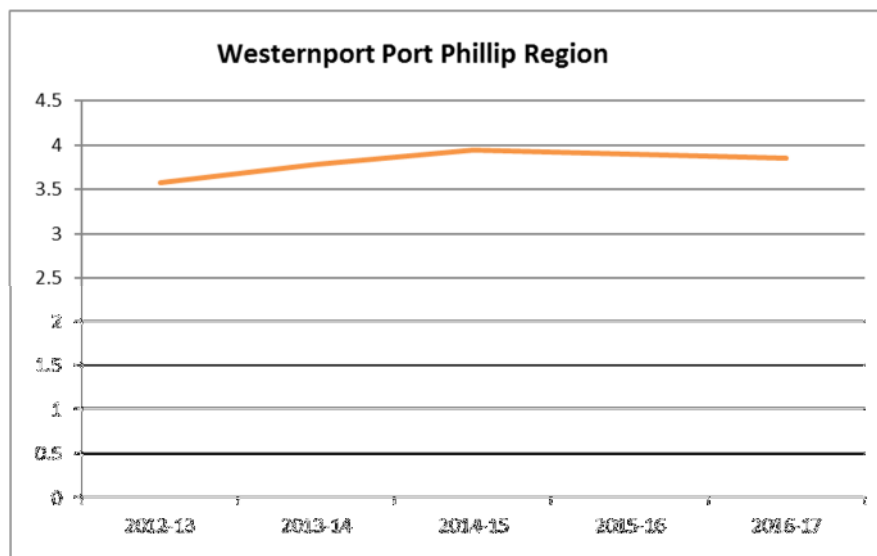
			Riparian Index	Number of species
Spearman's rho	Wetland Index	Correlation Coefficient	.534 **	.670 **
		Sig. (2-tailed)	.000	.000
		N	93	93
	Riparian Index	Correlation Coefficient		.586 **
		Sig. (2-tailed)		.000
		N		93
** . Correlation is significant at the 0.01 level (2-tailed).				

These results validate the application of the riparian and wetland sub-indices' as a way of measuring ecological condition, assuming that higher species diversity equates with better ecological condition.

### Shannon Diversity Index Results

Shannon diversity index combines both the number of species recorded and the abundance of individuals recorded to provide an index of diversity. The addition of the proportion of the population that a single species contributes to the overall community assemblage provides an additional dimension to this index not included in the previous sub-indices.

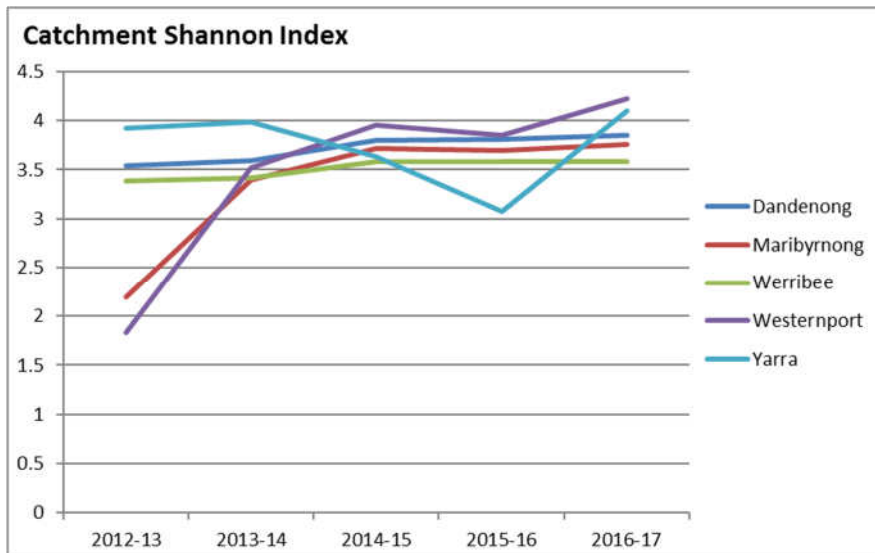
All data collected as a part of the MWrbm project were used to calculate catchment wide scores. Data were pooled across all sites and then equation 2 applied. Across the program period, there is little change in the calculated Shannon index across the catchment (Figure 24).



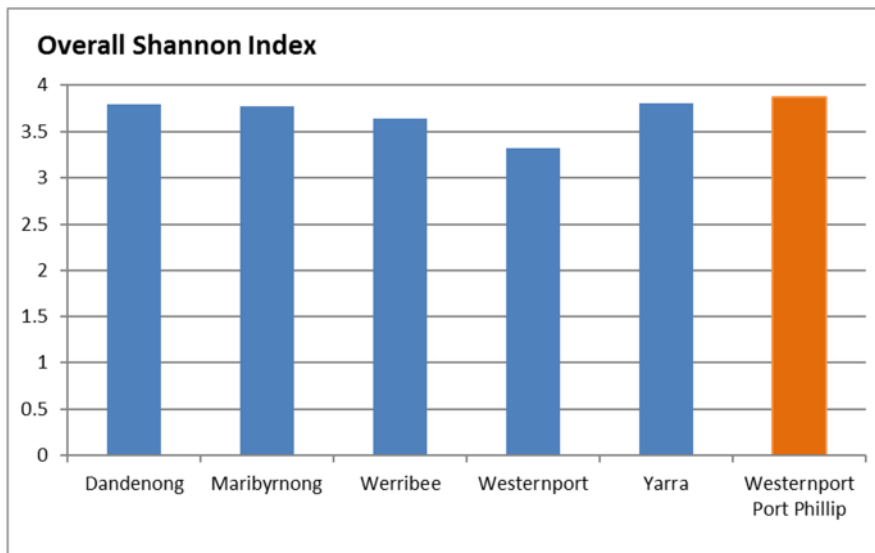
**Figure 24 Shannon Diversity Index over the 5 year survey period across the Westernport Port Phillip Region.**

Much more variability is seen between the sub-catchments with Westernport and Maribyrnong having significantly lower values during the beginning of the program period. For Maribyrnong this is probably reflective of survey effort, however the Westernport records, whilst showing a somewhat lowered species count, it is also found that the count of individuals is dominated by fewer species than in subsequent years, where the index increases. Dandenong and Werribee have remained stable over time. The drop in Yarra in 2015-16 can be attributed to unusually high counts of Eurasian Coots (23,522) and Blue-billed Ducks (15,384) being recorded across the sub-catchment. Yan Yean Reservoir recorded all Blue-billed ducks and 22,040 Eurasian Coots during this survey period.





**Figure 25** Calculated Shannon Diversity Indices across sub-catchments



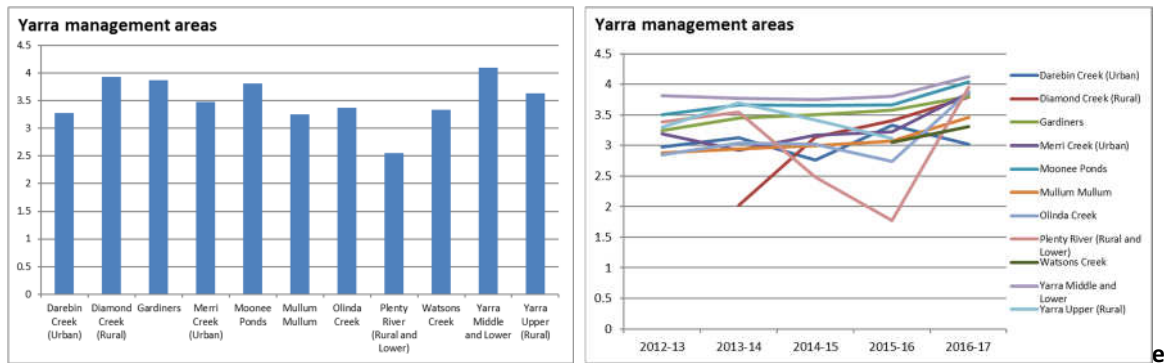
**Figure 26** Overall Shannon Index diversity for the Westernport Port Phillip catchment and sub-catchments.

Pooling data across the survey period generally diversity is quite even. Westernport is found to be slightly lower than the overall catchment value.

**Management Area Shannon Index.**

Refining the spatial scale from the catchment to the management units the variability in the bird diversity across the Westernport Port Phillip catchment begins to become more apparent. Whilst some catchments for example Dandenong show fairly even and consistent Shannon results, Yarra is much more variable. The influence of the high coot and blue-billed duck counts at Yan Yean Reservoir contribute to the decline in the score for Plenty River in 2015-16 (Figure 26e).





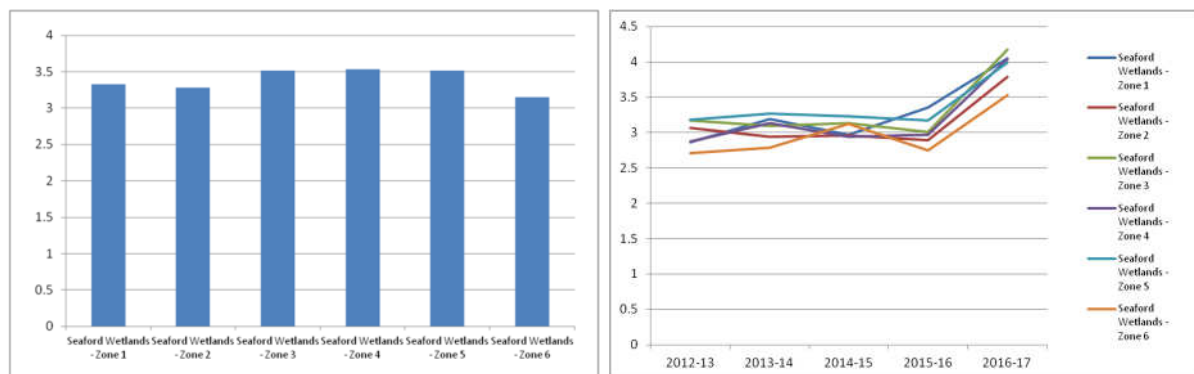
**Figure 27 a-e Overall Shannon Diversity Indices for management units and the annual scores for each of the survey periods. a: Dandenong Catchment, b: Maribyrnong Catchment, c: Werribee Catchment, d: Westernport Catchment, e: Yarra Catchment.**

*Shannon Diversity Index Scores for Sites*

For any site with count data available a Shannon diversity score has been calculated. This totaled 192 of the 235 survey sites included in the MWRbm program. The calculated scores for all sites can be found in Appendix 2. Category 1, works sites (Category 3) and constructed wetlands (Category 5) are examined in more detail below.

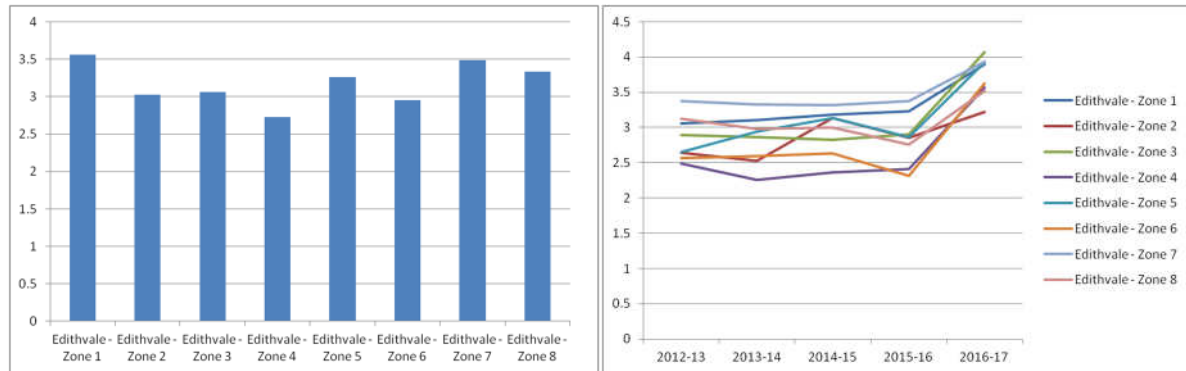
**Category 1 Sites**

Category 1 sites are those of high conservation value. This includes Ramsar sites, Flyway sites and Carram KBA sites. In total 52 sites within the MWRbm program fit into this category. These sites vary across remnant, retained native habitat (Edithvale and Seaford for example) as well as managed habitats found across the Eastern and Western Treatment Plants. Figures 28-32 show the overall (pooled) index score for each site as well as the annual trends over the 2012-17 program period. At sites where there are multiple zones this allows for a wider understanding as to how each of the different habitats available supports differing bird communities. At Seaford Zones three, four and five have higher Shannon scores than the other three zones (Figure 28a). This reflects the avian sub-indices scores to some extent. Differences in the Zone 1 results reflect the inclusion of introduced species in the Shannon calculation, and the reduction in the evenness of the abundance data. Counts across Zone 1 are dominated by Chestnut Teal (9827) which account for ~20% of all individuals counted at this site over the 5 year period. Zone 2 and 6 have less species recorded than the other areas. These are also areas that adjoin high residential development that may contribute to the diversity of birds found in these areas. Interestingly, across all zones we see a substantial increase in the index score in the 2016-17 period. This can be partly explained by more bird species recorded across the Zones in 2016-17 than previous years (except for Zone 1), but also much more evenness in the overall communities.



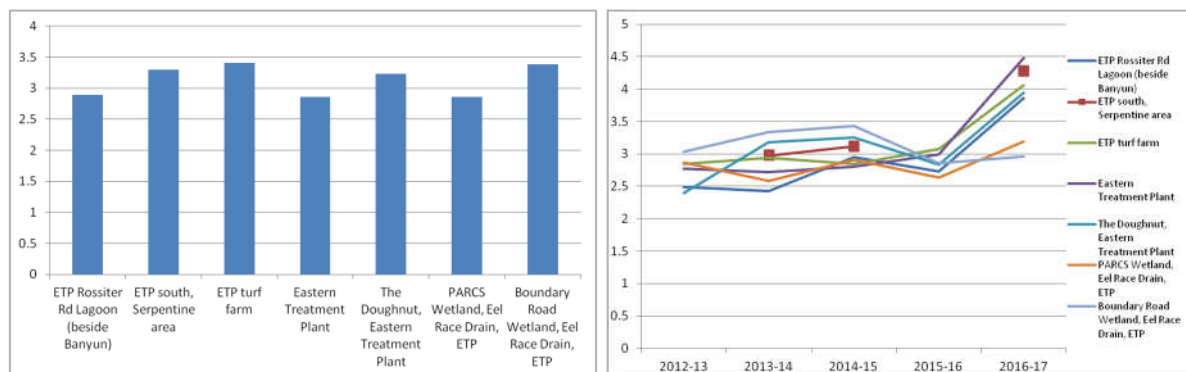
**Figure 28a and b Shannon Diversity Index for Seaford. a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

Calculated Shannon Diversity scores across Edithvale are much more variable than those for Seaford (Figure 29a and b). Again similarities with the avian sub-index are apparent, particularly for Zones 4 and 6. There is greater variation between sites over the survey period, than seen in the Seaford results, but similar to Seaford an increase can be seen in the score for 2016-17, particularly in Zones 3,4,5 and 6. This is accounted for by increases in species diversity – Zone 3 this includes 4 raptor species not previously recorded. Again, the lack of high numbers of water fowl in 2016-17 improves the evenness in species abundance, contributing to higher scores.



**Figure 29 a and b. Overall Shannon Diversity for Edithvale a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

Similarly Eastern Treatment Plant (ETP) sites increase in 2016-17 (Figure 30a and b), except Boundary Road Wetland. This site has shown a decline in diversity in 2015-16 which was sustained into 2016-17. Lower species diversity was recorded in 2016-17 which may explain the lower index score for this site.



**Figure 30a and b Overall Shannon Diversity for Eastern Treatment Plant a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

Western Treatment Plant sites are highly variable. This reflects the highly variable nature of the birds recorded at these sites. Between years not only the presence or absence of species fluctuates, but also the abundance of individual species. Significant changes can be seen at each site across years. The sharp decline at site WTP - T section Lagoon 1 reflects an inundation of the site by Eurasian Coots throughout that survey period. Of the 8000+ birds recorded at this site over the 12 month survey period 7000+ of these were Coots. Exploring the trough in the WTP - T section Lagoon 3 during the same period finds substantially fewer species recorded during this period (37 species compared to 85 the year before and 50 the year after). This decline in species numbers partly explains the trough. In addition to this decline in species, the abundance numbers are dominated by open water species such as Teal (Chestnut and Grey) and Black Swans. These bird assemblages are assumed to reflect changes in the water level, however sound data to test this assumption is not available, and many species of birds respond to larger scale influences than specifically what is happening at the site level. WTP - T section Lagoon 6 was completely dry for a period through 2014-15, to the point where the lagoon was fully grown over with vegetation. This period corresponds with a trough in the index score for this

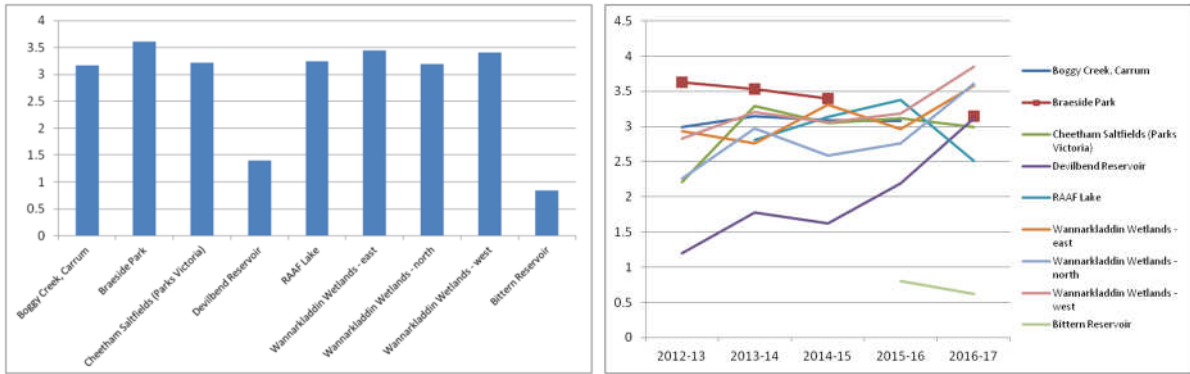
site, with the diversity index showing marked improvements since inundation occurred to return this site back to a wetland/water habitat.



**Figure 31a - e Shannon Diversity Index for Western Treatment Plant sites. a and b: pooled overall scores, c-e: annual score showing changes in the diversity at sites over the study period.**

Whilst looking at these diversity scores can identify changes in the bird communities at time periods, without additional habitat or management data it is not possible to determine what drives these changes, or how to maximize conditions to retain diversity (if this is indeed the best outcome for management).

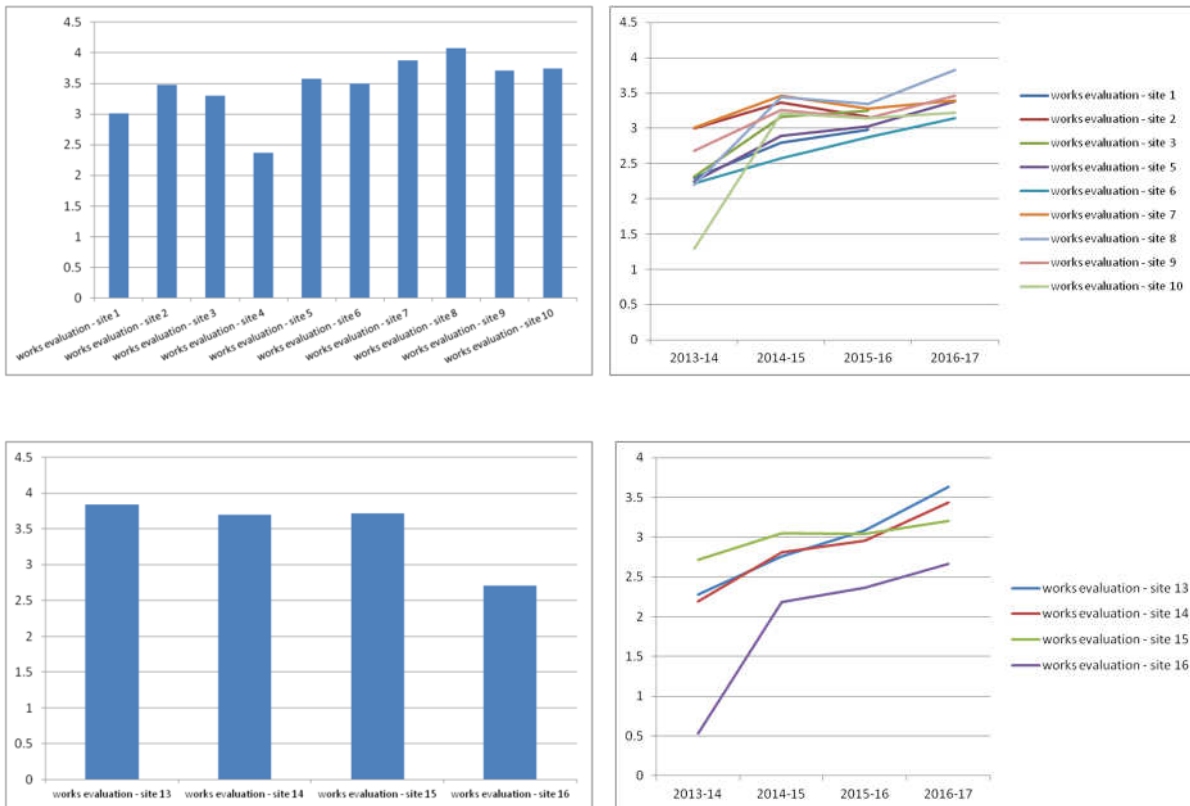
Shannon Diversity Scores for the remaining Category 1 sites are presented in Figure 32. Again Eurasian Coots seem to be the driving species behind the changes in the Devilbend Reservoir Shannon increase. For survey periods 2012-13 to 2014-15 this species accounted for 60-70% of the total number of birds recorded at this site. Across the 2015-16 surveys coots made up just over 40% of the birds recorded, with this dropping to just below 40% in 2016-17. This leads to greater evenness in the bird community (changing from a single species making up 70% of the population to 60% of the population represented by 92 species) and the subsequent increase in the Shannon Index. The movement of this species away from this site is probably the result of environmental conditions beyond the site level, and whilst we can say there have been shifts in the community at this site it is not possible to say why.



**Figure 32a-b Shannon Diversity Index for remaining Category 1 sites included in MWRbm. a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

**Works sites.**

One of the key aims of this monitoring project is to assess how onground works are contributing to the retention and improvement of ecological values in response to active management programs. A number of works activities have been undertaken including weed control. Unfortunately there is not pre-works data to determine if improvements in the diversity of these sites has occurred. Significant variation in the quality and habitats across control sites makes comparing works sites directly with control sites problematic (see figure 33a and b). Over time all the works sites across the Plenty River and Arthurs Creek/Running Creek system have shown increases in their diversity scores.



**Figure 33a -d Shannon Diversity Scores for works sites within the Plenty River and Arthurs Creek/Running Creek system. a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

Olinda Creek sites have fluctuated over time, however at present all three sites are showing similar diversity scores (Figure 34 a and b).

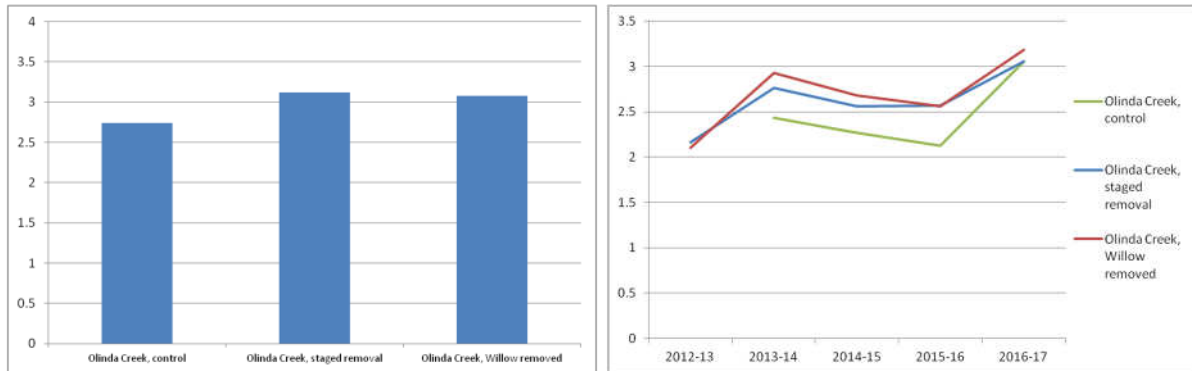


Figure 34a and b Shannon Diversity Index scores for works sites along Olinda Creek.

The remaining works sites are highly variable.

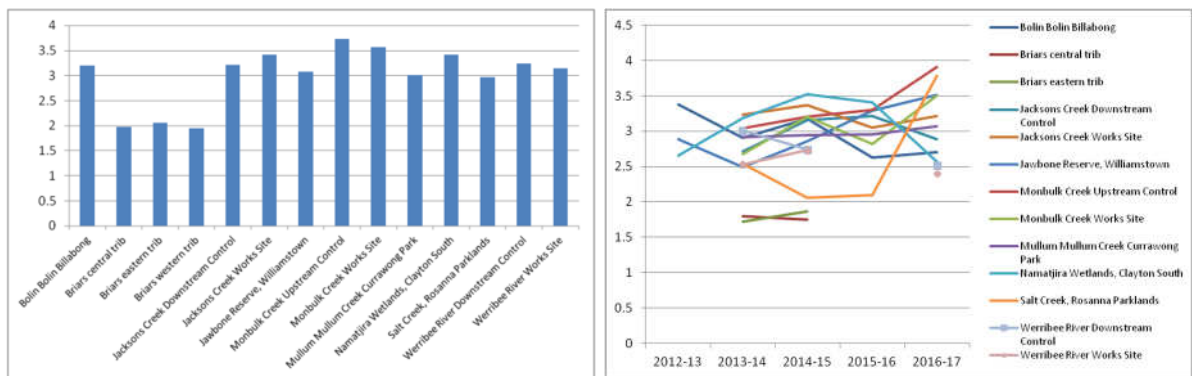
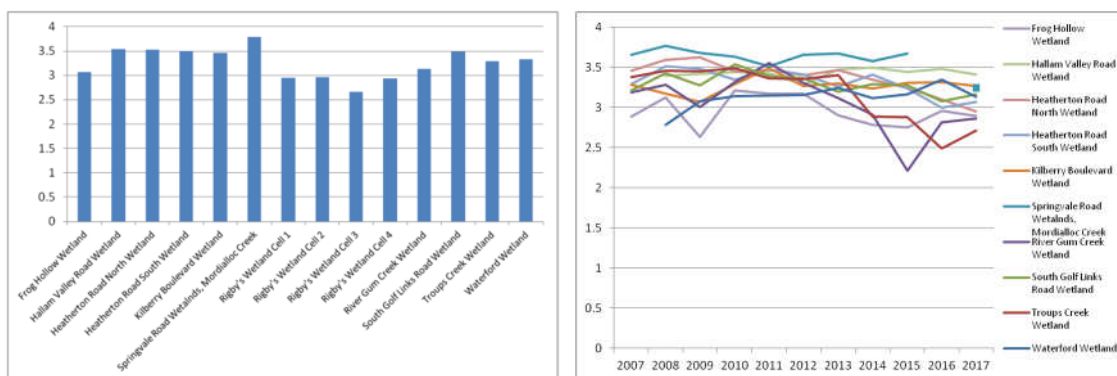


Figure 35a and b. Shannon diversity Scores for remaining works sites. a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.

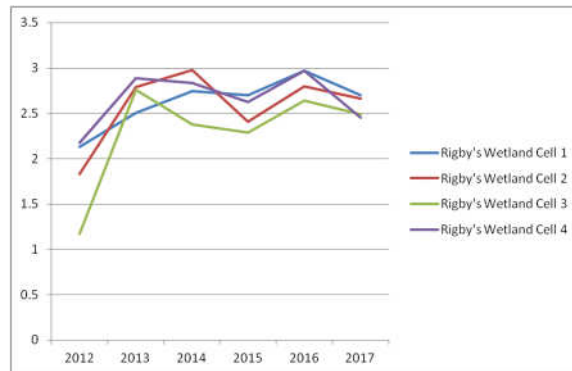
### Constructed Wetlands

During 2007 Melbourne Water contracted the then Bird Observation and Conservation Australia (BOCA) to establish systematic surveys across 10 constructed wetlands. Since 2012 an addition 4 sites (the Rigby's Wetland cells) have been added to this category of sites. Current Shannon Diversity scores show a decline at Troups Creek, South Golf Links Road and the two Heatherton Road sites (north and south). Rivergum Creek has a trough in 2015 which is explained by a dominance of Silver Gulls in the species assemblage over this year. Frog Hollow shows no consistency in the calculated diversity score over the period of the surveys (Figure 36a and b).





**Figure 36a and b. Shannon Diversity Index scores for constructed wetland sites. a: pooled overall score, b: annual score showing changes in the diversity at sites over the study period.**

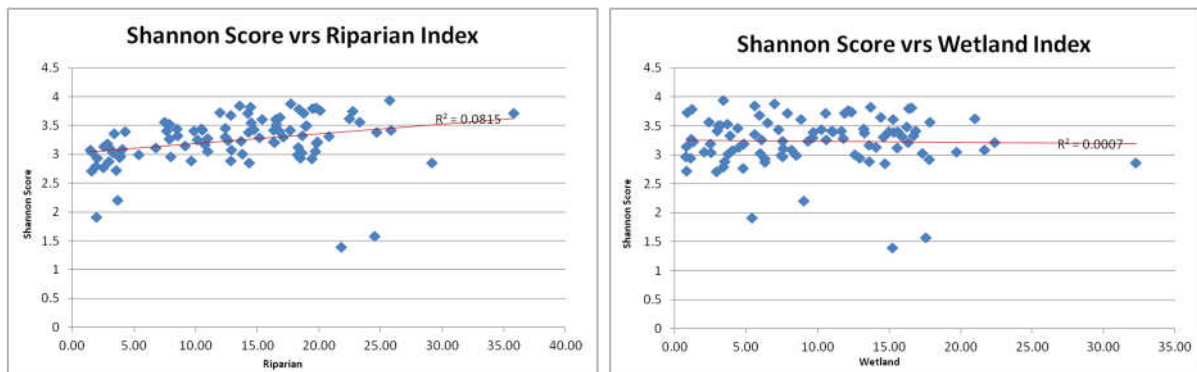


**Figure 37. Shannon Diversity Scores for Rigby's Wetland.**

Rigby's Wetland was constructed in 2010. Generally the calculated Shannon scores are lower across the four sites at this wetland than for the other constructed wetlands (Figure 37).

*Shannon Scores compared to Avian Sub-index*

Both the Avian sub-indices and the Shannon Diversity scores provide a method for detecting long-term trends in the bird communities occurring across the MWRbm sites. The different methods means that different information is communicated through each index. The relationship between the wetland and riparian index with the calculated Shannon scores was explored (Figures 38a and b).



**Figure 38a and b. Scatterplots of Shannon Diversity Scores compared to the riparian and wetland sub-index scores.**

Testing the relationship statistically not relationship is found between the wetland sub-index and the Shannon score. There is a statistically significant though weak correlation (co-efficient = 0.421, p = 0.001, n=93) between the riparian index and the Shannon Diversity scores.



## Significant populations

The assessment of ecological condition and diversity using a range of indices treats all species present at sites as equal. This means that a site may retain the same Shannon diversity score between years, but see one year support high conservation priority bird species that are lacking in other years, or if comparing between sites that those that support significant population of priority conservation species have lower diversity scores. The fluctuation and generally lower Shannon score across the WTP sites are examples of this.

The avian sub-indices derived by Steele (2011) use a range of common species, again not weighing scores for conservation values. However as custodians of several international, national and regionally significant wetland sites, Melbourne Water regularly report on occurrence, abundance, habitat quality and extent of threatened species, migratory species and significant populations of waterbirds. Several Melbourne Water sites, including Ramsar listed wetlands and Key Biodiversity Areas (KBAs – previously IBA's), are listed as such due to their significance for threatened and range restricted species, or internationally significant numbers of one or more shorebird species (>1% of the East Asian Australasian Flyway population) or overall populations of waterbirds (>20,000 waterbirds).

## Threatened species

A number of the sites included in the MWrbm are subject to sympathetic management designed to sustain threatened species populations of plant and animals in accordance with legislative obligations. By conserving habitats for these umbrella species, it is presumed that species (at several trophic levels) with less demanding spatial, physical, chemical and biotic habitat requirements will also be protected.

Over the 5 year survey period 58 species of bird that are listed under state or federal legislation as threatened have been recorded across the MWrbm sites. These species account for almost 20% of all species recorded (299 species in total across 5 years), and about 12% of the total bird count. These figures alone highlight how important these areas are for biodiversity retention across the Westernport Port Phillip catchment. These species are also spread across the catchment, with 167 sites having at least one species recorded. Table 18 shows threatened species recorded during the MWrbm surveys. Total counts for each survey period are provided as are the number of surveys where species have been found present. Also indicated is the total number of sites where each species has been recorded as present. For complete list of sites where priority species have been recorded see Appendix 3

**Table 18. Threatened species counts across all MWrbm sites from 2012-13 to 2016-17. Value in brackets ( ) indicates the number of surveys where species was recorded. Note that some years have no count data.**

	Total count 2012-13	Total count 2013-14	Total count 2014-15	Total count 2015-16	Total count 2016-17	Grand Total (count)	Total # sites present	Total # surveys present	EPBC Listing	Victorian Advisory Listing
Australasian Bittern	5 (5)	28 (24)	26 (23)	32 (23)	12 (12)	103	25	87	EN	EN
Australasian Shoveler	2470 (145)	2582 (183)	2059 (218)	1908 (225)	1682 (139)	10,701	92	910		VU
Australian Little Bittern	2 (2)	30 (30)			1 (1)	33	6	33		EN
Australian Painted Snipe		1 (1)				1	1	1	EN	VU
Azure Kingfisher			2 (2)		2 (2)	4	4	4		NT
Baillon's Crane	66 (28)	40 (23)	55 (37)	60 (42)	14 (12)	235	38	142		VU
Barking Owl		1 (1)					1	1		EN
Black Falcon	4 (4)	18 (17)	2 (1)	15 (14)	5 (6)	44	16	42		VU
Black-faced Cormorant	2 (1)	21 (6)				23	5	7		NT
Black-tailed Godwit	4 (2)	4 (4)	1 (1)	62 (11)	29 (9)	100	8	27	VU	VU
Blue-billed Duck	2974 (120)	3982 (191)	9600 (261)	18644 (307)	2425 (149)	37,625	66	1028		EN
Brolga	13 (5)	21 (11)	29 (17)	89 (37)	176 (54)	328	24	124		VU

	Total count 2012-13	Total count 2013-14	Total count 2014-15	Total count 2015-16	Total count 2016-17	Grand Total (count)	Total # sites present	Total # surveys present	EPBC Listing	Victorian Advisory Listing
Caspian Tern	10 (8)	23 (17)	29 (18))	32 (34)	22 (16)	116	30	93		NT
Common Greenshank	63 (34)	189 (67)	385 (94)	441 (124)	645 (97)	1723	46	416		VU
Common Sandpiper	13 (9)	13(11)	6 (5)	12 (11)	5 (4)	49	10	40		VU
Curlew Sandpiper	1196 (33)	4782 (84)	4856 (85)	3074 (68)	3319 (74)	17,227	42	344	CR	EN
Eastern Curlew			1 (1)	5 (1)		6	2	2	CR	VU
Eastern Great Egret	519 (321)	515 (346)	746 (514)	566 (498)	373 (266)	2719	113	1945		VU
Emu	14 (1)	79 (7)	30 (5)			123	1	13		NT
Fairy Tern	3 (3)	7 (2)	8 (8)	43 (3)	(1)	61	7	17	VU	EN
Freckled Duck	685 (48)	804 (79)	813 (80)	417 (59)	132 (22)	2851	43	288		EN
Great Knot		1 (1)			3 (3)	4	2	4	CR	EN
Grey Goshawk	1 (1)	2 (2)	2 (4)			5	5	7		VU
Grey Plover		1 (1)	1 (1)			2	1	2	NT	EN
Gull-billed Tern		3 (1)	4 (3)			7	3	4		EN
Hardhead	12269 (329)	12901 (307)	6605 (339)	3810 (300)	5048 (203)	40,633	110	1478		VU
Intermediate Egret	23 (17)	19 (17)	17 (15)	3 (3)	15 (13)	77	24	65		EN
Latham's Snipe	417 (101)	484 (107)	539 (138)	649 (223)	319 92)	2408	81	661		NT
Lewin's Rail	4 (5)	13 (13)	77 (33)	35 (25)	33 (25)	162	27	101		VU
Little Button-quail	2 (1)		2 (2)			4	1	3		NT
Little Egret	46 (23)	89 (56)	71 (38)	81 (43)	87 (36)	374	28	196		EN
Little Tern				20 (2)	16 (6)	36	4	8		VU
Long-toed Stint		1 (1)	1 (1)			2	2	2		NT
Magpie Goose	19 (14)	18 (13)	39 (19)	27 (17)	31 (17)	134	12	80		NT
Marsh Sandpiper	27 (15)	134 (40)	431 (58)	643 (99)	311 (48)	1546	36	260		VU
Musk Duck	300 (90)	358 (76)	314 (114)	282 (85)	150 (67)	1404	55	432		VU
Nankeen Night-Heron	224 (87)	43 (30)	237 (83)	325 (89)	136 (79)	965	50	368		NT
Orange-bellied Parrot	4 (1)					4	1	1	CR	CR
Pacific Golden Plover	(1)	116 (9)	17 (8)	10 (3)	3 (2)	146	7	23		VU
Pacific Gull	83 (50)	551 (142)	349 (96)	255 (131)	245 (106)	1483	36	525		NT
Pectoral Sandpiper	9 (7)	17 (10)	36 (12)	22 (13)	3 (3)	87	12	45		NT
Pied Cormorant	441 (54)	746 (66)	1280 (122)	693 (106)	857 (81)	4017	66	429		NT
Powerful Owl	(2)	(14)	2 (3)	1 (2)		3	6	21		VU
Red Knot		10 (3)		5 (3)	12 (3)	27	6	9	EN	EN
Red-chested Button-quail				2 (1)		2	1	1		VU
Royal Spoonbill	454 (158)	649 (205)	1068 (308)	1027 (294)	756 (165)	3954	101	1130		NT
Sanderling				(1)			1	1		NT
Sooty Oystercatcher	8 (2)	11 (7)	10 (3)	21 (8)	68 (16)	118	4	36		NT
Spotted Harrier	25 (23)	44 (37)	32 (27)	8 (3)	8 (8)	117	31	103		NT
Square-tailed Kite	(1)	5 (4)		1 (1)		6	4	6		VU
Swift Parrot	1 (1)	34 (5)	15 (3)	16 (6)		66	10	15	CR	EN
Terek Sandpiper					11 (9)	11	3	9		EN
Whiskered Tern	7683 (112)	6075 (147)	12471 (174)	10012 (177)	126 (21)	36,367	69	631		NT
White-bellied Sea-Eagle	10 (7)	13 (14)	19 (22)	30 (25)	43 (35)	115	42	103		VU
White-throated Needletail		51 (5)		53 (3)	5 (3)	109	10	11		VU
White-winged Black Tern	(1)	1 (1)	9 (4)	99 (12)	57 (7)	166	12	25		NT
Wood Sandpiper	4 (5)	13 (6)	30 (25)	73 (41)	17 (18)	137	20	95		VU

## Migratory Species

A number of the threatened species listed above are migratory shorebirds. Each spring and summer two million shorebirds migrate up to 11,000km from breeding grounds in the northern hemisphere to Australian wetlands and coasts. During this time shorebirds must derive enough energy from their chosen habitat to fuel the return trip to their breeding grounds the following autumn.

Recognising that the long-term conservation of viable populations of the world's species requires the identification, protection and management of their habitats, many governments have initiated conservation measures and signed international conservation agreements. The international agreements pertaining to Australia's shorebirds include the Ramsar Convention, the World Heritage Convention, the Bonn Convention, the Convention of Biological Diversity, the Asia-Pacific Migratory Waterbird Conservation Strategy and the East Asian-Australasian Shorebird Reserve Network. There are also several bilateral agreements, including the China-Australia Migratory Birds Agreement (CAMBA), the Japan-Australia Migratory Birds Agreement (JAMBA) and, most recently, the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA). In addition, Australia's Environment Protection and Biodiversity Conservation Act (1999) recognises migratory shorebirds as species of National Environmental Significance (NES), further highlighting the importance of shorebird conservation. All of these agreements require the identification and protection of areas for conservation.

### i) Global shorebird population trends

Throughout the world, many populations of shorebirds appear to be declining (Wilson 2000; Morrison *et al.* 2001; IWSG 2003; Olsen *et al.* 2003; CHSM 2004; van de Kam *et al.* 2004; Murray *et al.* 2013). In 2003, trend estimates were available for 41 per cent of the 499 populations of shorebirds around the world. Of these, 44 per cent appeared to be declining, 13 per cent were increasing, 39 per cent were stable and 4 per cent had become extinct (Delaney 2003; IWSG 2003). The population declines that were detected coincide with accelerating loss and degradation of shorebird habitat (United Nations Environment Programme 2006; Rogers *et al.* 2009; Murray *et al.* 2013). In the East Asian-Australasian Flyway, a disproportionately high number of shorebird species have been classified as threatened, and many are under increasing threat from habitat destruction (IWSG 2003; Murray *et al.* 2013). The Red List Index (RLI), which uses information from the IUCN Red List to track trends in the projected overall extinction risk of sets of species, is among the indicators adopted by the world's governments to assess performance under the Convention on Biological Diversity and the United Nations Millennium Development Goals. Of the 49 Australian species which had deteriorated in status in the last 20 years, over half were migratory shorebirds or seabirds (Szabo *et al.* 2012). Population-trend analysis of the BirdLife Australia Shorebird 2020 database shows strong evidence of declines in the Australian populations of 12 species of migratory shorebirds, and evidence of declines evident in another eight species of shorebirds (BirdLife Australia unpublished data).

In alignment with these identified trends of decline, the following migratory shorebird species were listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Critically endangered

- *Limosa lapponica menzbieri* (Bar-tailed Godwit (spp *menzbieri*))
- *Calidris tenuirostris* (Great Knot)

Endangered

- *Calidris canutus* (Red Knot)
- *Charadrius mongolus* (Lesser Sand Plover)

Vulnerable

- *Limosa lapponica baueri* (Bar-tailed Godwit (spp *baueri*))
- *Charadrius leschenaultii* (Greater sand Plover)

These species remain listed 'migratory' and 'marine' under the EPBC Act.

As custodian of internationally significant wetlands Melbourne Water undertake a wide range of works to manage habitat for migratory waders. The sympathetic management of non-tidal ponds at the Western Treatment Plant not only provides feeding and roosting habitat for up to >12,500 shorebirds (Rogers *et al.* 2014) but provides critical drought and sea-level rise refuge for a large suit of waterbirds.

**Table 19. List of East Asian-Australasian Flyway migratory shorebird species that occur in the Port Philip Westernport region.**

WPES estimate is the current global population estimates summed across relevant subspecies for the EAAF (Wetlands International 2016).

Conservation status refers to IUCN status listed in Garnett et al. (2010), except for bolded species which are listed in the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Department of the Environment 2016).

† these species have two or more subspecies which are recognised in the EAAF. Population estimates and thus, 1% population criterion, differ between subspecies and hence, the 1% criterion for each species is not presented here. See Waterbird Population Estimates (2016) for the most recent values.

\* Bar-tailed Godwit subspecies *menzbieri* listed as Critically Endangered and subspecies *baueri* listed as Vulnerable under recent (5 May 2016) EPBC Act changes.

Scientific Name	Common Name	WPES estimate	1% EAFP	Conservation status
<i>Pluvialis fulva</i> †	Pacific Golden Plover	135,000-150,000	1,350	
<i>Pluvialis squatarola</i>	Grey Plover	104,000	1,040	NT
<i>Charadrius bicinctus</i>	Double-banded Plover	50,000	500	
<i>Charadrius mongolus</i> †	Lesser Sand Plover	188,500-218,500	1,885	E
<i>Charadrius leschenaultia</i>	Greater Sand Plover	79,000	790	V
<i>Gallinago hardwickii</i>	Latham's Snipe	25,000-1,000,000	250	
<i>Limosa limosa</i>	Black-tailed Godwit	139,000	1,390	V
<b><i>Limosa lapponica</i> †</b>	<b>Bar-tailed Godwit</b>	<b>279,000</b>	<b>2,790</b>	<b>CE * / V</b>
<i>Numenius phaeopus</i>	Whimbrel	55,000	550	NT
<b><i>Numenius</i></b>	<b>(Far) Eastern Curlew</b>	<b>32,000</b>	<b>320</b>	<b>CE</b>
<b><i>madagascariensis</i></b>				
<i>Xenus cinereus</i>	Terek Sandpiper	50,000-55,000	500	
<i>Actitis hypoleucos</i>	Common Sandpiper	50,000	500	
<i>Tringa brevipes</i>	Grey-tailed Tattler	44,000	440	NT
<i>Tringa nebularia</i>	Common Greenshank	100,000	1,000	
<i>Tringa stagnatilis</i>	Marsh Sandpiper	100,000-1,000,000	1,000	
<i>Tringa glareola</i>	Wood Sandpiper	100,000	1,000	
<i>Arenaria interpres</i>	Ruddy Turnstone	28,500	285	NT
<b><i>Calidris tenuirostris</i></b>	<b>Great Knot</b>	<b>290,000</b>	<b>2,900</b>	<b>CE</b>
<b><i>Calidris canutus</i> †</b>	<b>Red Knot</b>	<b>99,000-122,000</b>	<b>1,100</b>	<b>E</b>
<i>Calidris ruficollis</i>	Red-necked Stint	315,000	3,200	
<i>Calidris subminuta</i>	Long-toed Stint	25,000	250	
<i>Calidris melanotos</i>	Pectoral Sandpiper	1,220,000-1,930,000	12,200	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	160,000	1,600	
<b><i>Calidris ferruginea</i></b>	<b>Curlew Sandpiper</b>	<b>135,000</b>	<b>1,350</b>	<b>CE</b>
<i>Calidris pugnax</i>	Ruff	25,000-100,000	250	

**Table 20 Migratory species identified under the EAAFP recorded during MWRbm surveys. Provided are total counts for each of the survey periods. The number of surveys each species was recorded as present is given in ( ). The maximum count for each survey period is also provided. This is important in assessing the significance of records against the 1% criterion of the EAAFP. Numbers in **bold** indicate species that meet international criteria.**

	Total count 2012-13	Total count 2013-14	Total count 2014-15	Total count 2015-16	Total count 2016-17	Grand Total (count)	# sites	# surveys	EPBC Listing	1% EAA	maximum count 2012-13	maximum count 2013-14	maximum count 2014-15	maximum count 2015-16	maximum count 2016-17
Bar-tailed Godwit	2 (2)		1 (1)	51 (4)	7 (4)	61	6	11		2,790	1	0	1	35	3
Black-tailed Godwit	4 (2)	4 (4)	1 (1)	62 (11)	29 (9)	100	8	27	VU	1,390	2	2	1	10	5
Common Greenshank	63 (34)	189 (67)	385 (94)	441 (124)	645 (97)	1,723	46	416		1,000	6	17	71	64	45
Common Sandpiper	13 (9)	13(11)	6 (5)	12 (11)	5 (4)	49	10	40		500	3	2	2	2	2
Curlew Sandpiper	1196 (33)	4782 (84)	4856 (85)	3074 (68)	3319 (74)	17,227	42	344	CR	1,350	294	500	500	947	400
Double-banded Plover	158 (8)	930 (27)	838 (28)	696 (21)	1006 (25)	3,628	22	109		500	95	332	128	157	230
Eastern Curlew			1 (1)	5 (1)		6	2	2	CR	320		0	1	5	0
Great Knot		1 (1)			3 (3)	4	2	4	CR	2,900		1	0	0	1
Grey Plover		1 (1)	1 (1)			2	1	2	NT	1,040		1	1	0	0
Latham's Snipe	417 (101)	484 (107)	539 (138)	649 (223)	319 (92)	2,408	81	661		250	30	28	37	30	50
Long-toed Stint		1(1)	1(1)			2	2	2		250		1	1	0	0
Marsh Sandpiper	27(15)	134(40)	431(58)	643(99)	311(48)	1,546	36	260		1,000	9	20	70	100	50
Pacific Golden Plover	(1)	116 (9)	17(8)	10(3)	3(2)	146	7	23		1,350		29	8	4	2
Pectoral Sandpiper	9(7)	17(10)	36(12)	22(13)	3(3)	87	12	45		12,200	2	3	8	4	1
Red Knot		10(3)		5(3)	12(3)	27	6	9	EN	1,100		6	0	4	10
Red-necked Stint	9227 (74)	21844 (110)	18045 (144)	11590 (114)	18859 (87)	79,565	47	529		<b>3,200</b>	1380	2800	1128	2000	<b>6800</b>
Ruddy Turnstone			2 (1)		5 (3)	7	4	4		285		0	2	0	2
Ruff		2 (2)	1 (1)		1 (1)	4	4	4		250		1	1	0	1
Sharp-tailed Sandpiper	11344 (90)	18213 (152)	18318 (212)	24645 (210)	4775 (91)	77,295	62	755		<b>1,600</b>	<b>2600</b>	<b>3540</b>	<b>3200</b>	<b>3500</b>	1180
Terek Sandpiper					11(9)	11	3	9		500		0	0	0	2
Wood Sandpiper	4(5)	13(6)	30(25)	73(41)	17(18)	137	20	95		1,000	1	6	3	6	2

During the study period from mid 2012 to mid 2017, 21 species of migratory shorebirds were observed at MWrbm sites during standardised surveys. There are a number of instances where single survey counts meet the East Asian-Australasian Flyway Partnership (EAAF) criteria of 1% of global populations. Currently two sites included in the EAAF are managed by Melbourne Water (see Figure 39). Both these locations also fall within current Key Biodiversity Area (KBA) boundaries. As seen in table 20 the counts for Sharp-tailed Sandpiper have been at greater than 1% of the population over the 2012-16 period at Edithvale. This may qualify this site for listing under the flyway partnership and nomination of this site could be considered. Numbers were significantly reduced in 2017 however (Figure 40). This is believed to have been in response to inland conditions which meant birds simply did not arrive at the site. A maximum count of about 50 birds was anecdotally taken for Edithvale across the 2016-17 season. Maximum counts for 2016-17 season was made at WTP – Western Lagoon Ponds. This number was unusually high compared to previous years at this site.

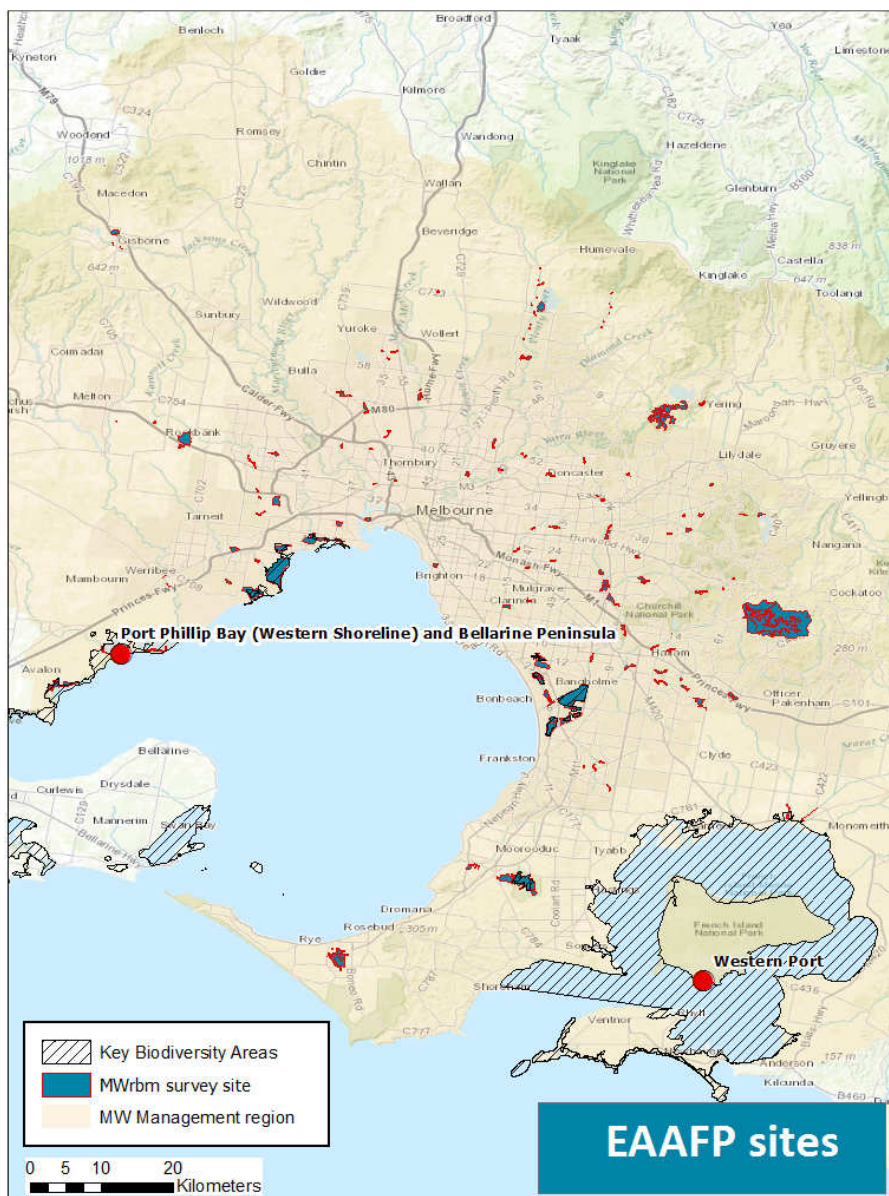
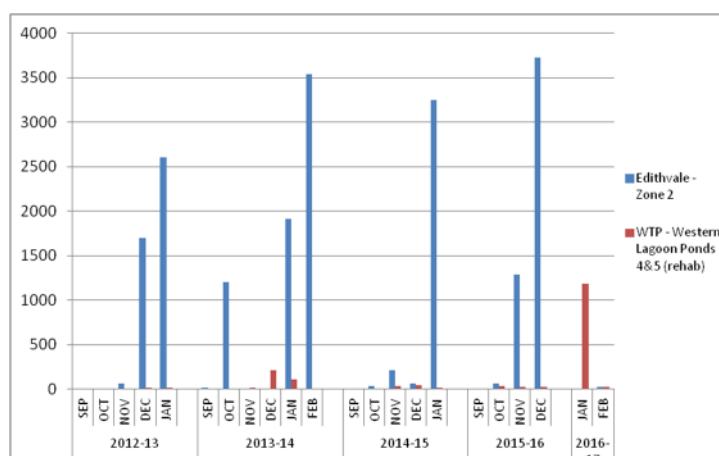


Figure 39 East Asian - Australasian Flyway Partnership sites managed by Melbourne Water.





**Figure 40. Annual maximum Sharp-tailed Sand Piper counts at Edithvale and WTP over 2012 -2017. Counts at Edithvale have consistently reached over the EAAFP 1% criteria.**

Latham’s Snipe do not commonly aggregate, or use the same sites as other migratory species, which means that habitat important to this species is not always identified using the general EAAFP method of 1% of the population (EAAFP 2017). Criteria used to assess significant habitat for Latham’s Snipe is recognized as areas that have previously been identified as internationally important for the species, or areas that support at least 18 individuals of the species.

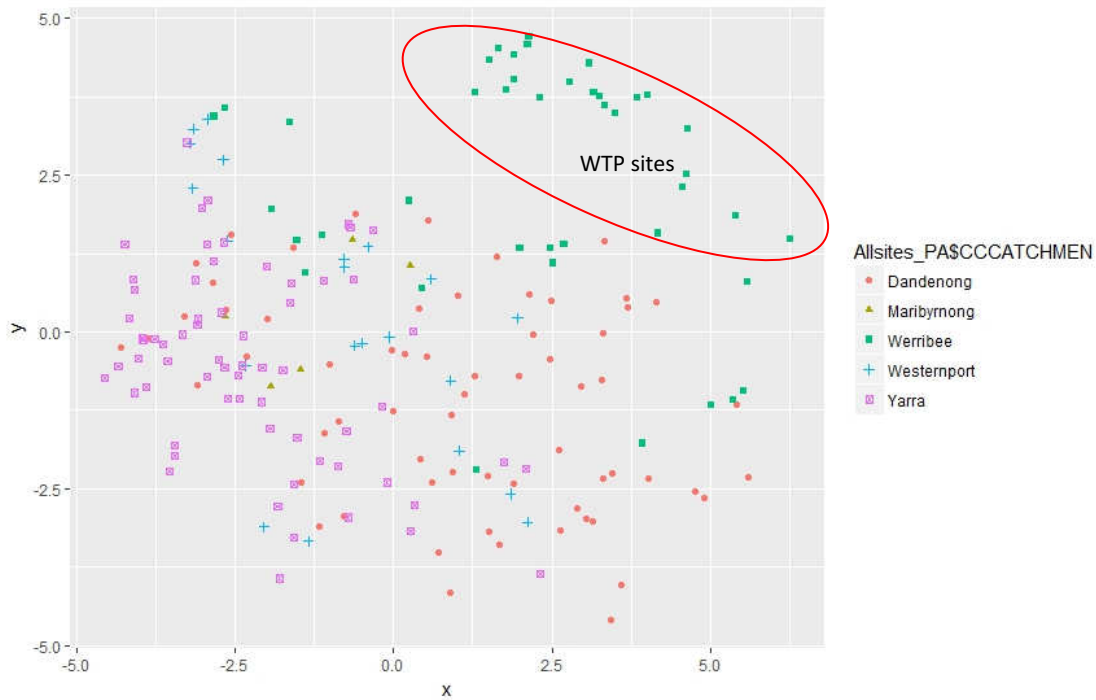
Over the 5 years of this monitoring project Latham’s Snipe have been recorded at 73 sites (Appendix 4). Many of these have been a single record, but some sites support significant numbers (>18) across each of the five year periods. Edithvale particularly supports high numbers of this species annually (Table 21).

**Table 21 Latham’s Snipe records across survey sites that meet the EAAFP criteria of >18 individuals recorded.**

Site Name	2012-13	2013-14	2014-15	2015-16	2016-17	Grand Total
Berwick Springs wetlands	67	6	9	1		83
Eastern Treatment Plant	28	57	33	41	19	178
Edithvale - Zone 2	10	11	27	10	3	61
Edithvale - Zone 7	3	97	105	77	70	352
Edithvale - Zone 8	61	1			1	63
Edithvale Total	76	110	135	90	80	491
Karkarook Park	42	12	21	1		76
Rigby's Wetland cell 3	24				2	26
Rigby's Wetland Total	24	4	1		2	31
Seaford Wetlands - Zone 1	63	80	74	22	47	286
Seaford Total	63	81	75	23	47	289
The Doughnut, Eastern Treatment Plant	57	29	28	13	6	133
Tirhatuan Wetlands, Dandenong Creek		19	23	14	3	59
Tootgarook Swamp - 92W	23	1				24
Tootgarook Swamp - Truemans Rd landfill		2				2
Tootgarook Total	24	7	6	4		41
Waterford Wetlands, aka Karoo Road Wetland,	62	83	97	48	61	351



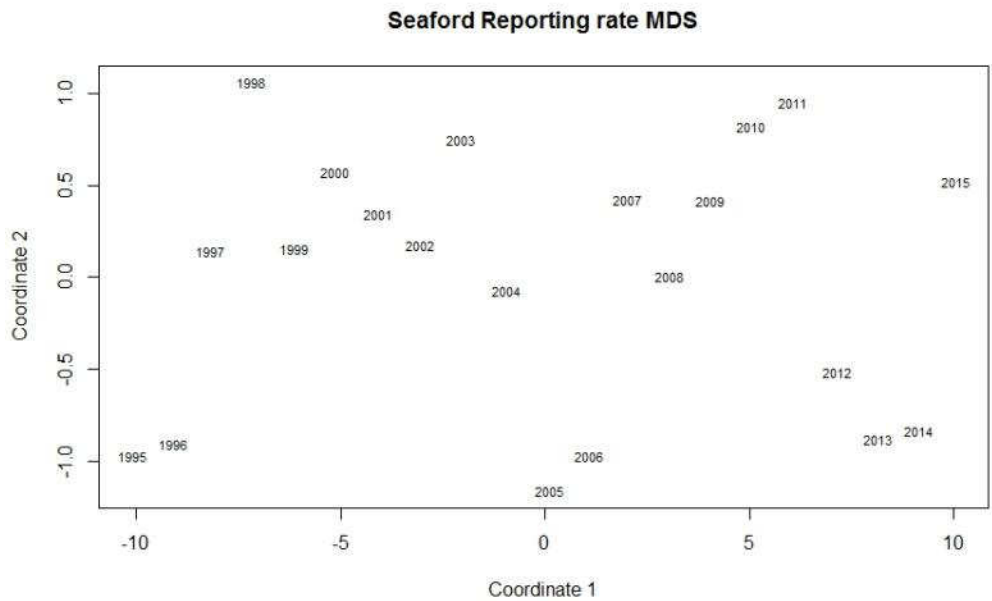




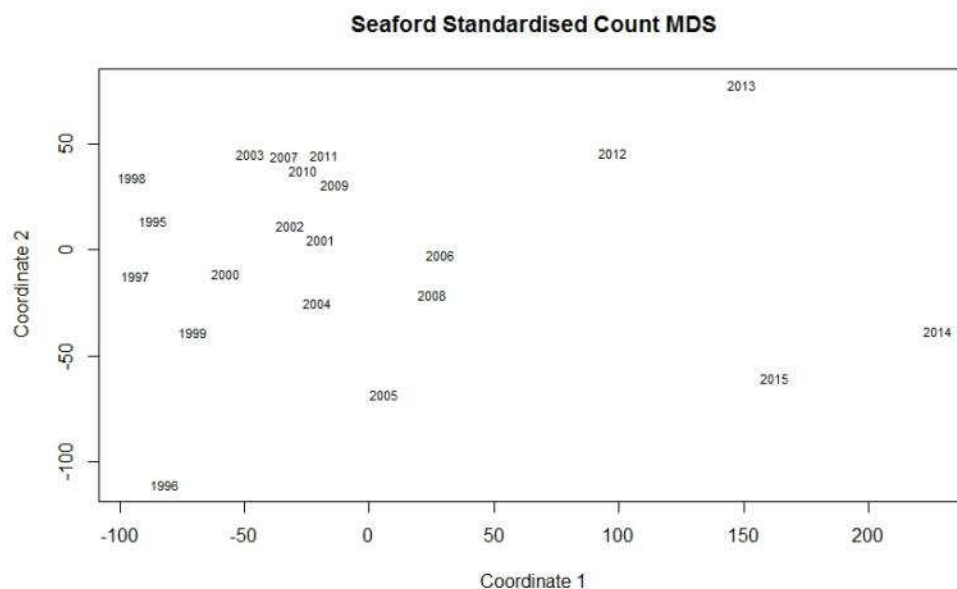
**Figure 42 MDS plot of all survey sites included MWrbm plotted by subcatchment (see 2016 progress report for further details)**

**Seaford**

Seaford has had standardised surveys undertaken since mid-1994 by the same three surveyors and only these data have been used in the current analysis. Both 1994 and 2016 have been excluded from the current analysis due to incomplete survey data at the time of analysis.



**Figure 43 MDS plot of reporting rate data for Seaford.**



**Figure 44 MDS plot of standardised count data for Seaford.**

Whilst the resulting MDS plots differ in the spread of the yearly data, both show the last four years (2012-2015) to be quite different to the preceding years; 1996 and possibly 2005 also differ from the other years.

As the MDS plots [dis]similarity between years trying to understand where these differences lie requires exploration of the original data. The first obvious difference is the total number of species recorded during each year. Table 22 shows this. It can be seen that over the last four years higher numbers of species have been recorded than in previous year. 2005 also has a higher species diversity than other years. We also see higher standardised counts during these years (including 1996).

**Table 22 Survey data for Seaford used in the exploratory MDS. Count data is standardised for survey effort**

Year	# species	Standardised count
1995	104	928
1996	109	<b>1209</b>
1997	96	862
1998	90	808
1999	94	1160
2000	93	1044
2001	100	1006
2002	96	827
2003	94	742
2004	108	1081
2005	<b>115</b>	<b>1208</b>
2006	110	1122
2007	98	874
2008	110	1155
2009	98	979
2010	105	910
2011	103	883
2012	<b>118</b>	<b>1356</b>
2013	<b>119</b>	<b>1383</b>
2014	<b>119</b>	<b>1749</b>
2015	<b>113</b>	<b>1482</b>

The changes in long term abundance trends and the reporting rates were explored for all species recorded as present at Seaford. Count data have been standardised for survey effort (total count divided by number of surveys). Six species show declines in their abundance over the years. The reporting rates for these species vary between remaining stable over the survey period, or reflecting the abundance trend and showing a decline over the survey period (Appendix 5A).

Four of these bird species are introduced species and as such the decline in their abundance (if not their reporting rate) is not of concern. However the decline in the White-fronted Chat should trigger consideration of a management response. Chats, Skylarks, Starlings and (to a lesser extent) Goldfinch are all open country species (HBW). The declines in the abundance of these species suggest that preferred open habitat is becoming more vegetated. Anecdotal observations during bird surveys support this, with increasing vegetation cover across sections of the site (A. Silcocks pers. comm.). Surveys in 2016 -17 have seen a slight increase in the counts of White-fronted Chats at Seaford (with 9 and 12 individuals respectively), though numbers are still significantly lower than previous counts.

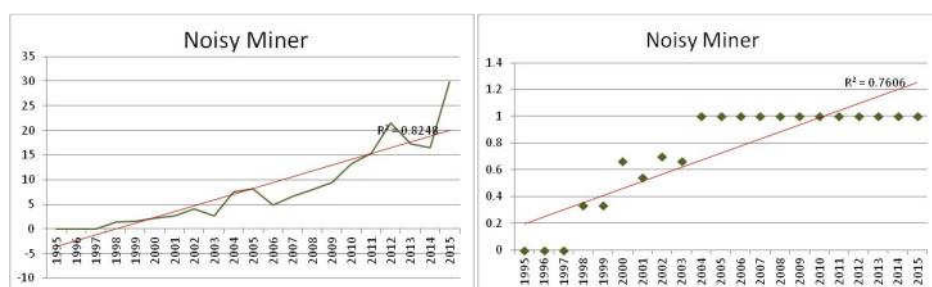
Black Swans have never been abundant at the site, though they are consistently reported as present. These birds forage on submerged vegetation, the presence of which is associated with water quality and depth. The decline in the Black Swan populations at Seaford may be indicative of changing water quality or levels that could be a management concern. Further investigation may be warranted by Melbourne Water.

Nine species of birds have been identified as increasing in abundance over the monitoring period (Appendix 5A). The reporting rates for these species show some interesting trends. For species such as Red Wattlebirds, Rainbow Lorikeets, Chestnut Teal and White-plumed Honeyeaters; these species have always been present at high frequencies across the Seaford site. It is the abundance data where the changes are apparent in these species. The two honeyeater species and the Rainbow Lorikeet are known to benefit in urban environments with changes in backyard and street vegetation contributing to increases in their populations (Fitzsimons et al. 2003). Grey Butcherbirds, which appear to have become resident at the site also benefit from increasing urbanisation (Catterall *et al.* 2010). Larger landscape effects are likely influencing these species above the onground management of Seaford.

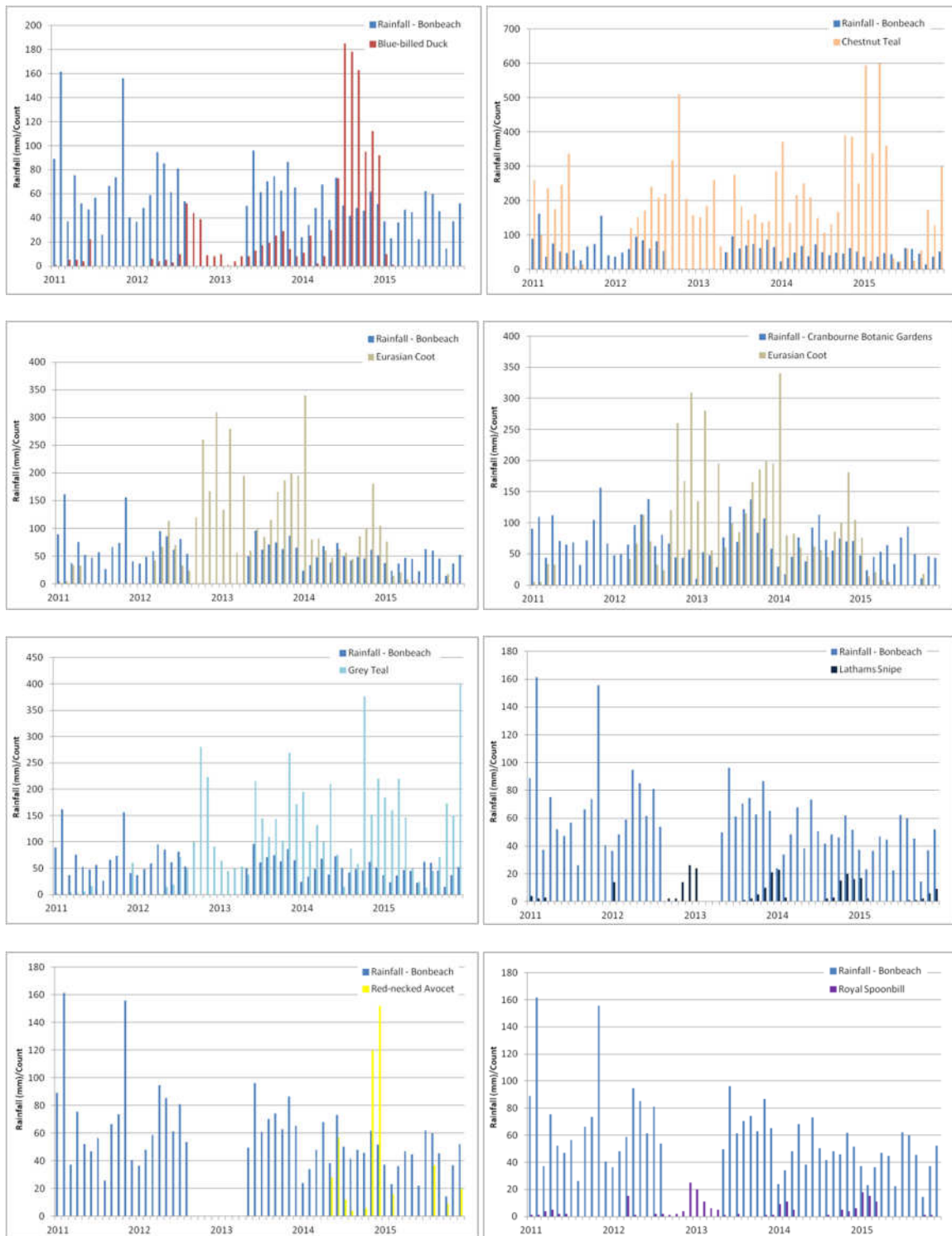
Eastern Rosella, Eastern Yellow Robin, Grey Fantails, and Brown Thornbills (none of which thrive in urban environments) have become more frequent in their reporting over time, from infrequent records to being reported at every visit. Again the abundance data show major increases in these species. Localised, onground management of Seaford is likely to have a direct impact on these species. The increase in these species at the site suggests that the retention of this habitat is becoming increasingly important in retaining these species in the more urbanised landscape.

Of most interest is the Noisy Miner. This species was not present at the site until the late 1990's (Figure 45a and b). There is a six year period where this species becomes established at the site, with the main colony in Zone 5 (North west wooded section of the Seaford Wetland). This appears to be the main location of the Noisy Miners, however over time the abundance and frequency of this species is increasing in zones 2 and 6, where the wetland immediately adjoins the private gardens of surrounding residences.

Changes in waterfowl populations were explored against rainfall data as well as water level data. For a number of species numbers remained stable over much of the dataset held for Seaford, with surges in populations over the 2012-15 period. Rainfall data was sourced from the Bureau of Meteorology (BOM) website for the Bonbeach and Cranbourne Botanic Gardens weather stations.



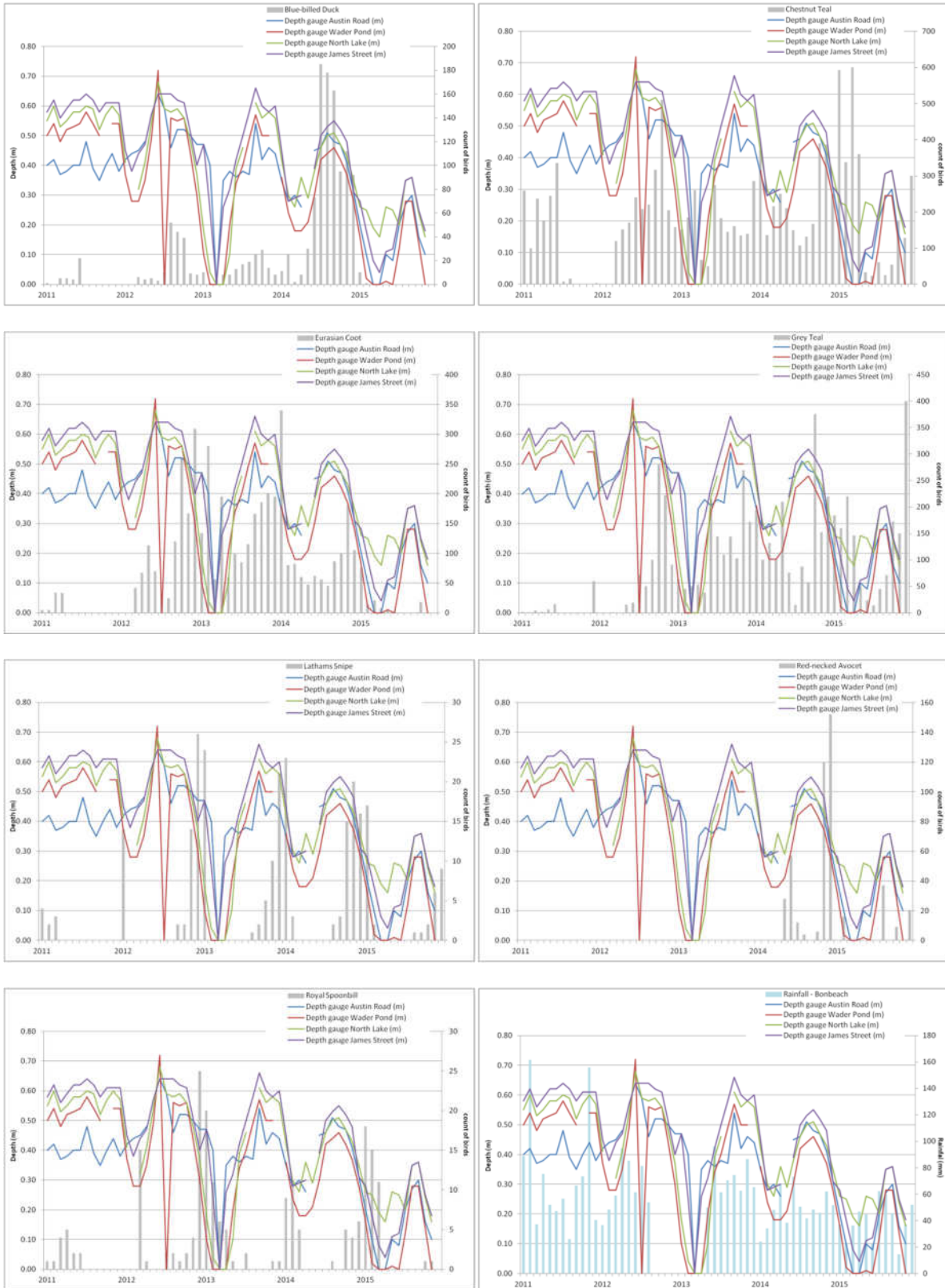
**Figure 45a and b Long-term trends in the abundance and reporting rates of Noisy Miner at Seaford**



**Figure 46a - h Abundance data for selected wetland species plotted against rainfall data**

There is some relationship between rainfall and species abundance, with most species appearing to increase in abundance after periods of rainfall. It does not appear strong however. Further statistical exploration of the data may reveal a more conclusive relationship.

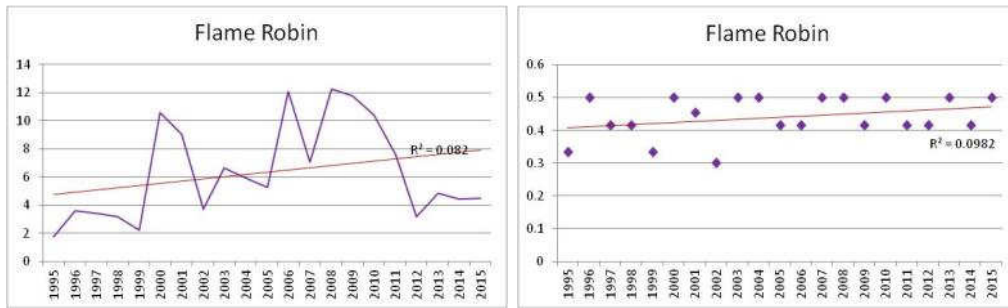
Counts for these same species were plotted against depth gauge data. There is a much stronger relationship between gauge data and abundance, with species most abundant during peak water levels. Latham's Snipe, Red-necked Avocets and Royal Spoonbills show a lag, with numbers highest as water levels begin to decline. Again, further statistical exploration of this relationship may be warranted.



**Figure 47a-j Selected wetland species abundance data (secondary y axis) plotted against water depth (Primary Y axis) for Seaford. Figure j shows rainfall data plotted against depth data**

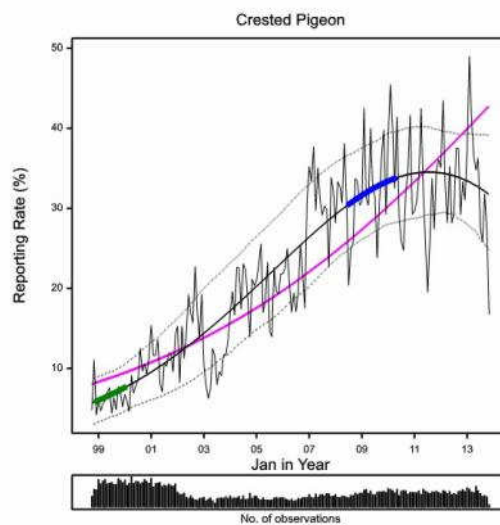
There are a few species that were identified as being of interest due to potential changes in the current habitat availability. Flame Robins (Figure 47 and b) have been identified as a species that anecdotally appear to be

declining. Count data show a decrease in the abundance of birds since 2008/09, however the frequency of occurrence has remained consistent.



**Figure 48a and b. Changed in Flame Robin abundances over time at Seaford and corresponding reporting rates**

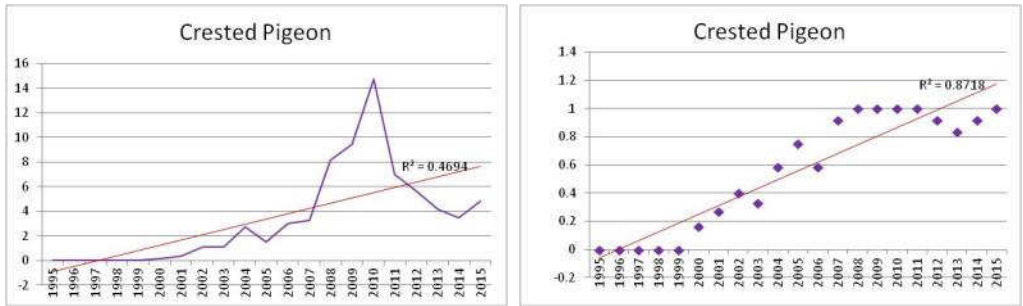
Like with the Noisy Miner data (see above) we can track the ‘invasion’ of Crested Pigeons across Seaford. This species of bird has moved into the Melbourne area and has been recorded with increasing frequency since the late 1990’s. Figure 49 shows the modelled changes in the probability of occurrence for this species across metropolitan Melbourne between 1999 – 2014 (K. Herman unpublished data). Frequency of reporting maximises around 2010/11.



**Figure 49 Modelled trend of Crested Pigeon across Metropolitan Melbourne since 1998.**

Across Seaford we see the gradual increase in the frequency of this species in the recorded bird assemblage until 2008, where it becomes a permanent species at the site (Figure 50a and b). This does not however reflect the abundance data, where a peak in the numbers can be seen in 2010, and then numbers stabilising somewhat at a lower level.

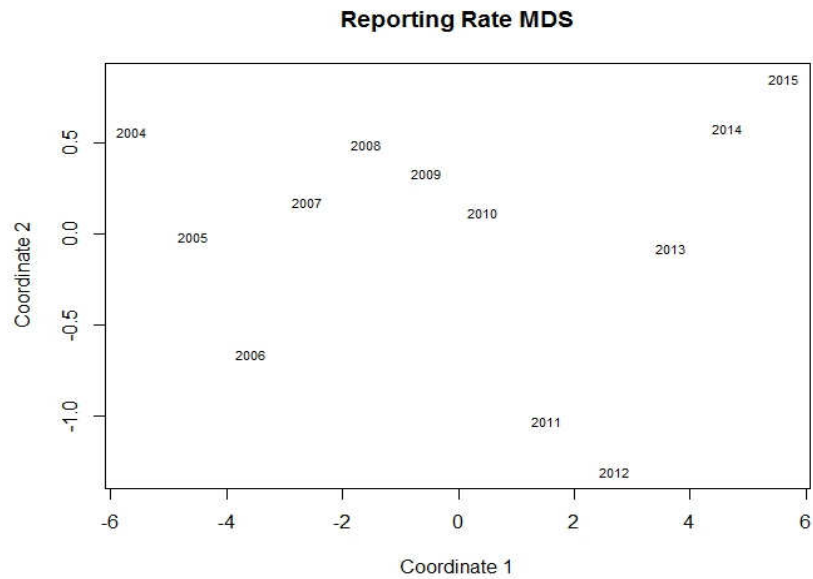




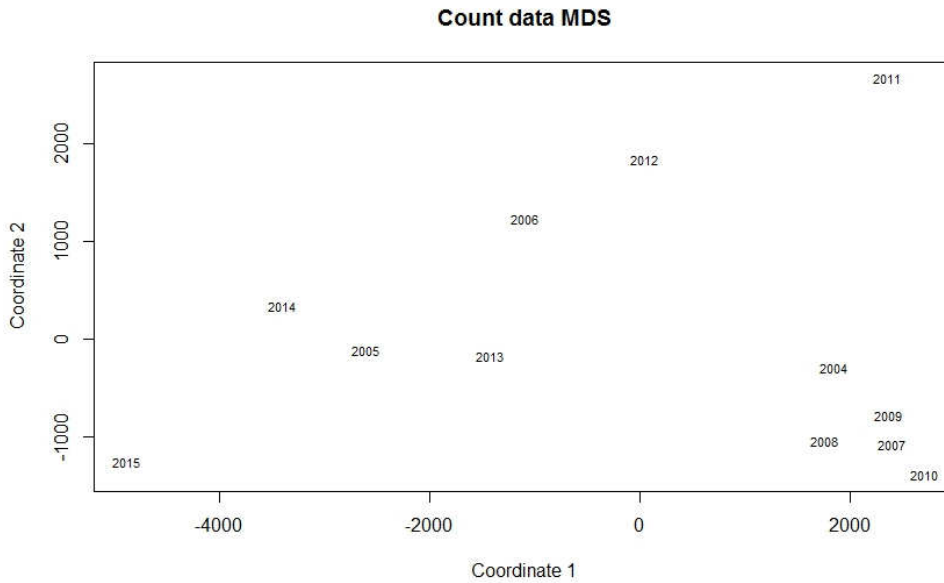
**Figure 50** Long-term changes in Crested Pigeon abundance and reporting rates.

### Edithvale

As with the Seaford data, the Edithvale surveys have been carried out by the same observer. All years have also had equal survey effort (12 per year) and as such total numbers have been used for abundance trends rather than standardised counts.



**Figure 51** MDS plot of Reporting Rates for Edithvale between years.



**Figure 52 MDS plot for count data for Edithvale.**

The count data shows a grouping of years - 2004, 2007, 2008, 2009, 2010 in the bottom right corner of the plot. Remaining years are fairly evenly spread across the remaining area of the MDS plot with 2011 and 2015 falling into the far top and bottom corners. Reporting rates see similarities in the species assemblage between 2011 and 2012 and 2013-15 plot as more similar than other years.

**Table 23 Summary of survey data and abundance data for Edithvale. Figures in bold correspond to grouping seen in Figure 52.**

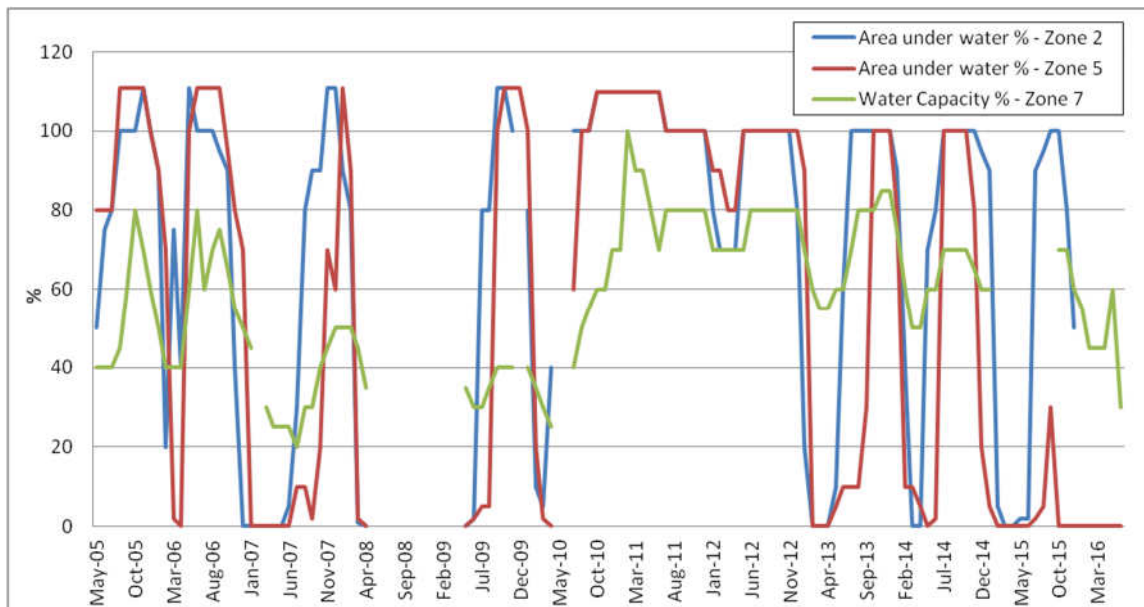
Year	# species	Total Abundance
2004	100	<b>13156</b>
2005	103	21168
2006	112	22128
2007	109	<b>10361</b>
2008	108	<b>11595</b>
2009	102	<b>10236</b>
2010	94	<b>8029</b>
2011	115	20589
2012	117	22096
2013	115	19411
2014	115	23318
2015	106	21670

For count data we see that the years that form the cluster in the MDS plot have reduced total abundance data than other years. Exploration of the individual bird species trends identify a number of waterfowl species that are substantially decreased in abundance during this time period. The period 2007-2010 is during the height of the drought period and just as it breaks in 2010.

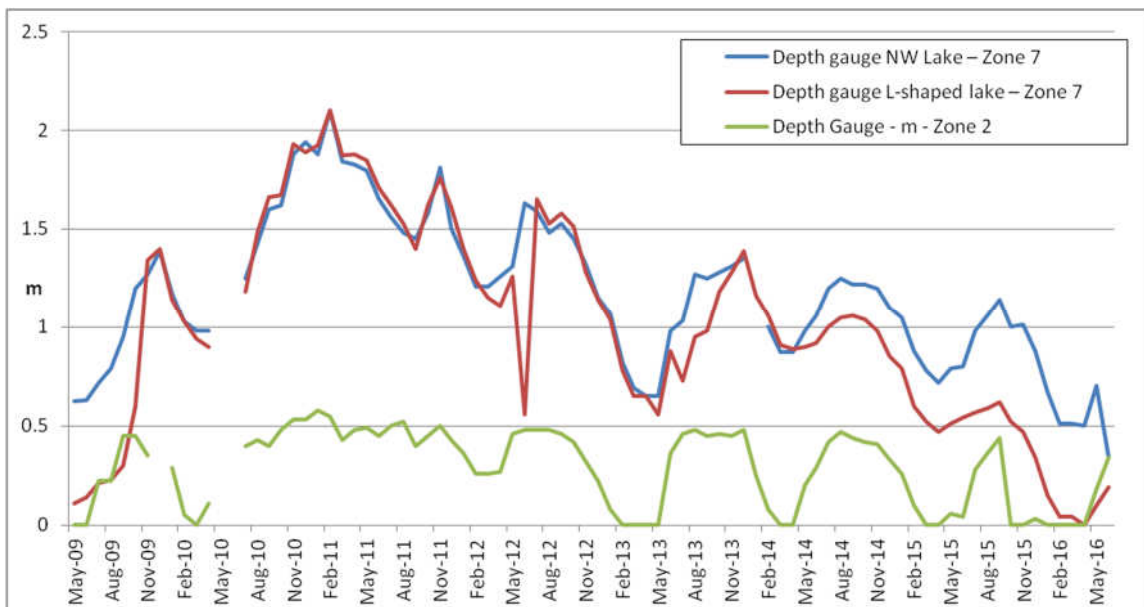
The decreases in the abundance data over this period is driven by the reduction in the presence of a number of waterfowl species. Appendix 5B show the long term count trends and reporting rates of these species.



Figure 53 presents indication of water levels across the Edithvale site from 2005 – 2016. There is some reflection in the bird data with a dryer period from 2007 – 2010 seen in the Zone 7 water capacity estimates (though data is missing for this period). Depth gauge data from May 2009 onwards also suggests higher water levels from mid 2010 (Figure 54).



**Figure 53 Water capacity estimated for Edithvale**



**Figure 54 Depth gauge data for Edithvale**

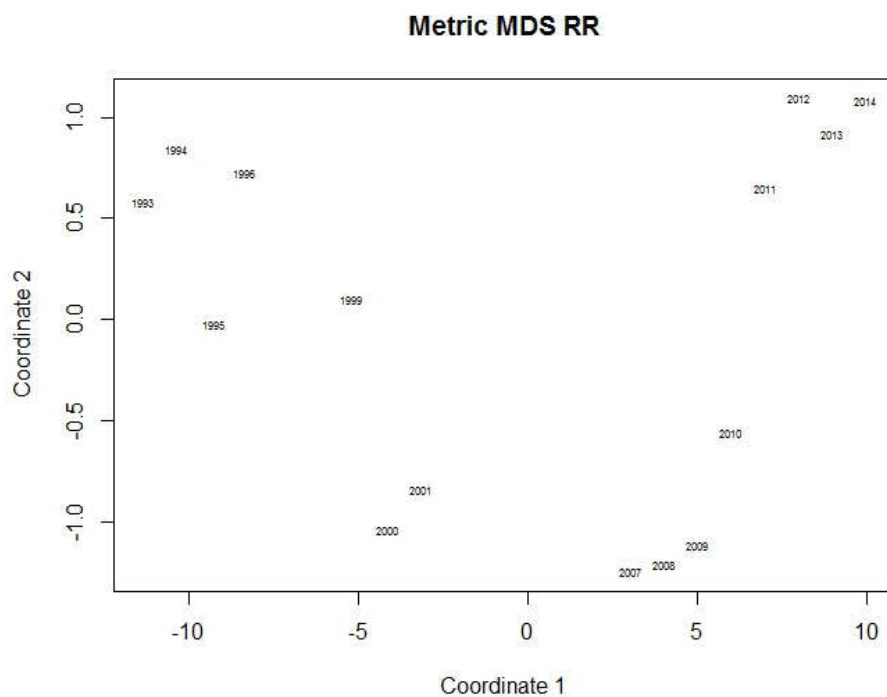
A number of species are showing declines in abundance, though for many species the reporting rate remains stable. Numbers of Golden-headed Cisticolas and Australasian Bittern have gone down over the study period. Bittern numbers particularly declined over the drought period. This may be due to lowering water levels, but it is thought that this species is strongly influenced by national level conditions rather than local conditions and the lack of this species at the site indicates better habitat elsewhere (A. Silcocks pers comm.). In 2016 Bittern

numbers remained stable, with *Cisticola* numbers slightly lower than 2015. Counts for 2017 so far suggest *Cisticolas* will remain stable.

Nineteen species of birds were found to be increasing in abundance over the 2004-15 period (Appendix 5B). These are all terrestrial, woodland species, except for Latham's Snipe. 2016-17 saw major decline in the Lathams Snipe numbers recorded for Edithvale with 54 counted for 2016. Other increasing species are a mix of more open country species – such as Galahs, Red-rumped Parrots and Yellow-rumped Thornbill that forage across open spaces and small bush birds such as Brown Thornbills, Grey Fantail and White-browed Scrubwrens that require more understorey complexity.

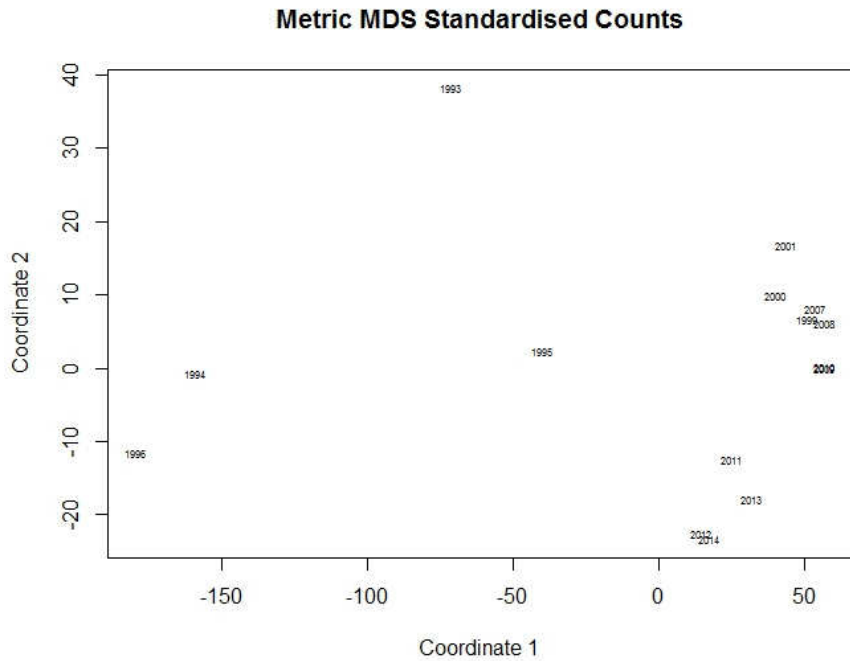
### Braeside Park

Braeside Park is part of the Carrum KBA. The site is surveyed by a range of volunteers, including a Friends group who have been surveying consistently since 1993. Detection biases between survey participants may occur, however they are difficult to determine and ignoring non-detection may be better than trying to account for it (Welsh *et al.* 2013). Additionally the confidence in the consistency of count data for this site is not as high as that for Seaford, so whilst count data is presented here potential observer biases need to be considered. Due to lack of surveys there is not data available for 1997-98, 2002-6 and 2015. Braeside Park is not managed by Melbourne Water.



**Figure 55 MDS plot of reporting rate data for Braeside Park, Carrum KBA**

Braeside shows distinct annual differences, with clear groups forming around the early-mid 1990's late 1990's and early 2000 and 2011-14.



**Figure 56 MDS plot of standardised count data for braeside Park, Carrum KBA**

Species trends for this site fall distinctly into two categories – species going up in frequency of occurrence and abundance and species going down in frequency and abundance. This split falls almost completely between woodland birds and wetland species, with woodland birds increasing and all wetland species, apart from Hardheads and Australian Darter, decreasing. Hardhead and Darter frequency and abundance have shown increases over the survey period. Both these species are divers – foraging for invertebrates or fish in deeper water. This increase in these species and the decline in the dabbling species such as Teal and Swans may indicate long term changes to the standing water depth at the site. Other diving species such as Grebes and Cormorants are showing variable long term trends. Nankeen Kestrels and Black-shouldered Kites have also declined. These species are probably influenced by landscape changes such as increasing urbanization and decreasing open space for foraging. Brown Falcons (whilst never abundant at the site) appear to be on the increase after decline across the site. Great Egret, Dusky Moorhen and Little Pied Cormorants show a similar trend Appendix 5C).

**Table 24 Summary of data used in the MDS exploration for Braeside Park.**

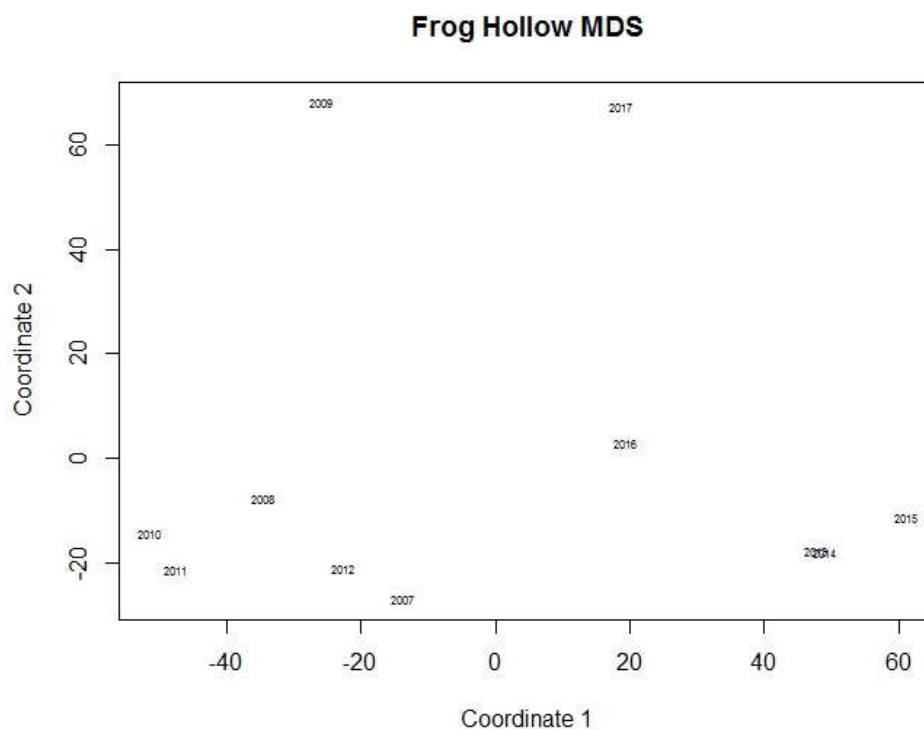
	# species	Standardised Count
1993	70	461
1994	78	659
1995	78	345
1996	61	609
1997		
1998	47	0
1999	75	35
2000	82	94
2001	95	93
2002		
2003		
2004	50	0
2005	52	0
2006	65	37
2007	82	78
2008	87	83
2009	79	116
2010	77	123
2011	<b>98</b>	<b>220</b>
2012	<b>99</b>	<b>234</b>
2013	<b>95</b>	<b>244</b>
2014	<b>92</b>	<b>261</b>
2015	71	138

### Constructed Wetlands.

Systematic surveys have been undertaken on a monthly basis across 10 constructed wetlands in the Dandenong catchment. These were initiated in 2007 and have generally continued over the past 10 years. Surveys are undertaken by the same volunteers so like Edithvale and Seaford surveys the potential for observer biases are reduced in this dataset.

All data available for these sites was included in this analyses; 2017 includes only 6 months of data. This should be considered in interpretation of the MDS plots. MDS plots were formed using standardized count data to account for differences in survey effort between years. Standard counts are the total number of individuals divided by the number of surveys undertaken (mean).

## Frog Hollow Wetlands



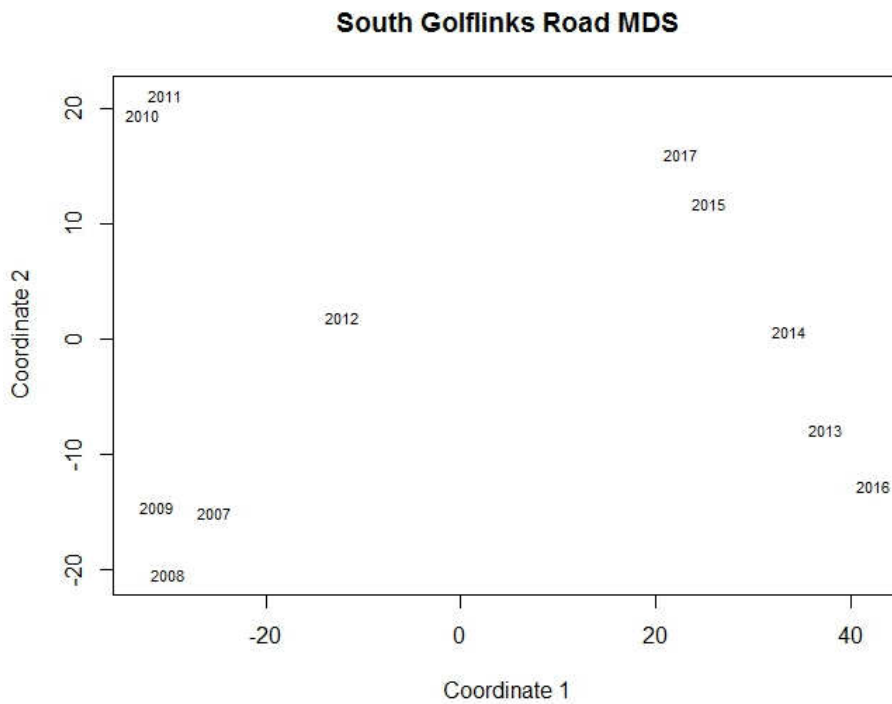
**Figure 57 MDS plot for Frog Hollow Constructed Wetlands using standardised count data**

**Table 25 Summary of Frog Hollow Data used in MDS.**

	# species	Total count (standarised)
2007	48	190
2008	65	200
2009	67	275
2010	56	197
2011	51	178
2012	57	256
2013	61	368
2014	57	362
2015	51	395
2016	65	336
2017	56	449

There is a split between years (2007-2012 and 2013-2017) on co-ordinate 1 of the MDS plot that that reflects the change in the calculated Shannon Score (Figure 36b). The score is generally lower in the later years suggesting that a few species may account for a higher proportion of the total bird count. Figures for species can be found in Appendix 5D These show that particularly Eurasian Coots are prevalent across this site during this latter period, with numbers substantially higher in than at the beginning of the survey period. Silver Gulls also account for a high proportion of the bird count. The peak in this species in 2009 may be contributing to both the dip in the Shannon Score, and the position this year takes on the MDS plot.

**Golflinks Road**

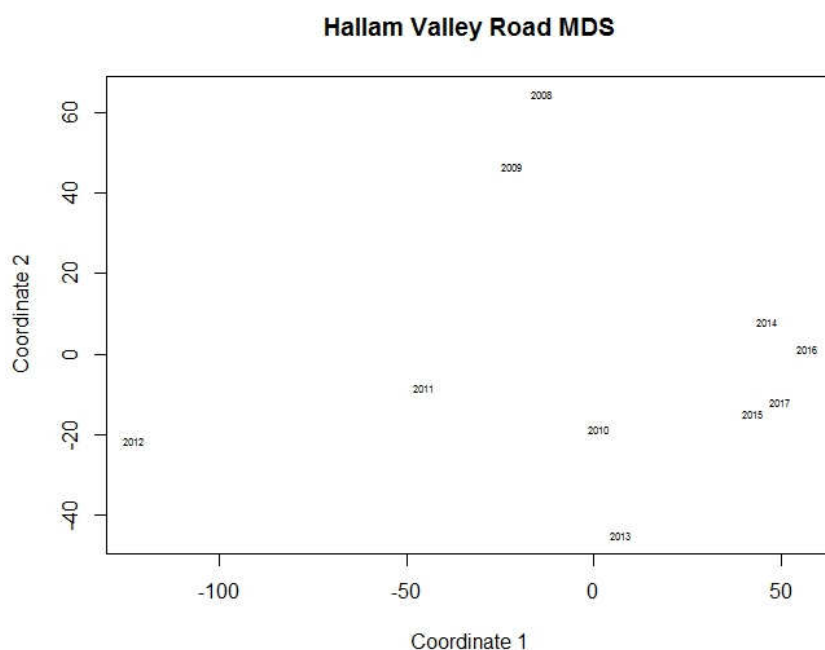


**Figure 58 MDS plot for Golflinks Road Constructed Wetlands using standardised count data.**

**Table 26 Summary of Golflinks Road data used in MDS**

	# species	Total Count (standardised)
2007	62	193
2008	65	222
2009	61	225
2010	74	370
2011	76	343
2012	71	326
2013	72	343
2014	72	371
2015	75	373
2016	66	333
2017	60	370

The MDS plot shows a group of years 2007-09. These three years have a lower abundance of birds recorded than for later years which may account for this grouping. A second group of 2010-11 occur, with 2012 plotted independently of all other years. Species trends can be found in Appendix 5E.



**Figure 59 MDS plot for Hallam Valley Road Constructed Wetlands using standardised count data**

**Table 27 Summary of Hallam Valley Road data used in MDS**

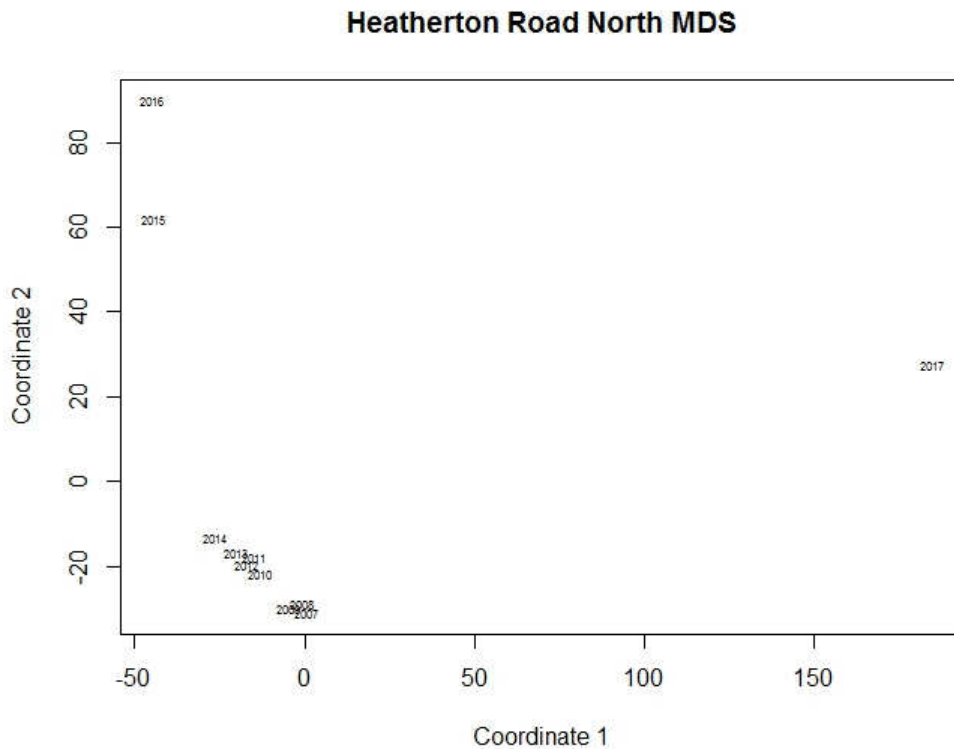
	# species	Total count (standardised)
2008	75	529
2009	85	611
2010	83	741
2011	90	764
2012	86	878
2013	86	674
2014	72	469
2015	74	518
2016	75	484
2017	54	498

The MDS plot for Hallam Valley Wetland plots 2012 as an outlier compared to other years. 2014-17 also form a tight cluster. The calculated Shannon Scores for this site are fairly stable, suggesting that it is not the evenness of the bird community that causes 2012 to split for the rest of the years. Table 27 shows a higher overall abundance in 2012 compared to other years. Exploring the abundance data for all species recorded at Hallam Valley over the survey period, a number of species show peaks in the abundance counts in 2012 (Appendix 5F).

A few species are showing increases in their abundance. Australian Magpies and Noisy Miner are species that are able to readily exploit modified urban habitats. Grey Butcherbirds and White-plumed Honeyeaters are becoming more prevalent in remnant vegetation in urban spaces as these species adapt to the changed landscape.

A number of declining species like Pipits and Skylarks are open country birds. The decline of these species may indicate plantings becoming mature, with increasing vegetation cover and structure across the site (or area in general). Water capacity assessments undertaken in conjunction with bird surveys have found the site to be below capacity around 70% of the time since mid 2014. This timing fits with plateaus in the numbers of some of the waterbirds recorded across the site. Declines in Reed-warblers, Cisticolas and Grassbirds suggest that there may be management considerations to be made around reeds and emergent vegetation.

**Heatherton Road North**



**Figure 60 MDS plot for Heatherton Road North Constructed Wetlands using standardised count data**

Heatherton Road North has had a consistent bird community recorded up until 2015. 2015-16 and 2017 all fall individually across the MDS plot, with the remaining years forming a tight group. This is probably reflective of the overall abundance of individual birds recorded across surveys.

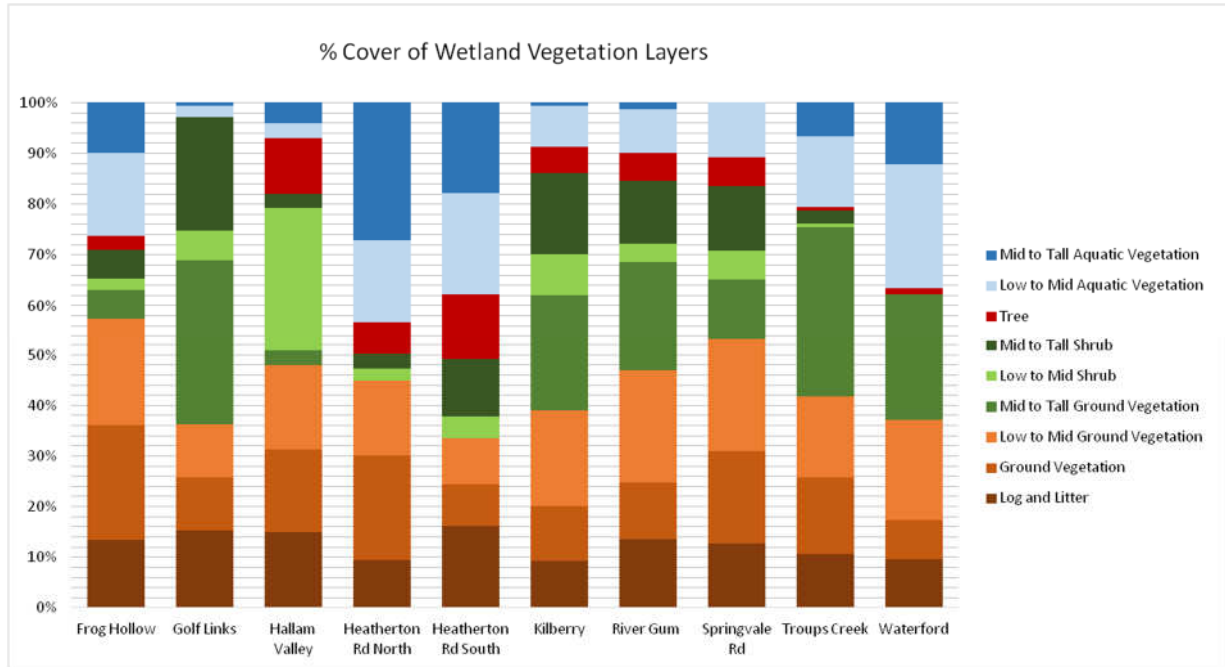
**Table 28 Summary of Heatherton Road North data used in MDS.**

	# species	Total count (standardised)
2007	54	171
2008	73	218
2009	68	233
2010	75	335
2011	80	394
2012	74	416
2013	77	430
2014	75	437
2015	76	526
2016	73	473
2017	66	608

There are a number of bird species that show dramatic changes in their abundance over the past three years. This may be either increases or decreases. Spotted Pardalotes become prevalent on the site in 2011 and Mistletoebirds have increased since 2012. Noisy Miners, whilst present on the site, are not at the numbers seen at other locations. This suggests that there are habitat elements present on this site (for example

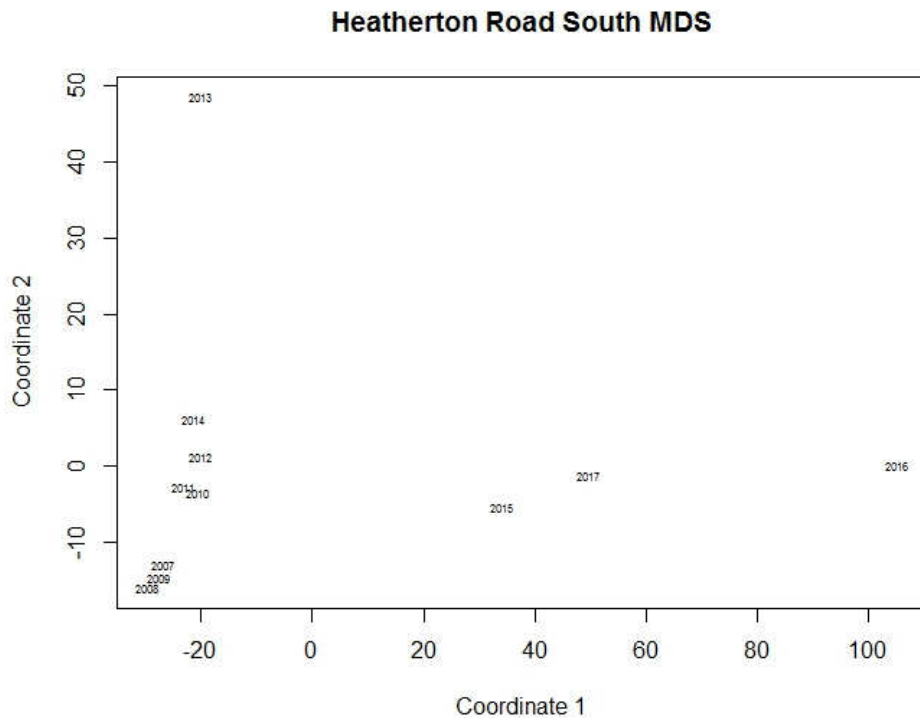


structured understorey) that may be lacking in other sites. Champness and Taylor (2015) undertook a quick assessment of habitat structure across the constructed wetlands in 2014 (Figure 61). There are few clear trends in the bird at this site (Appendix 5G).



**Figure 61** Vegetation assessment undertaken across constructed wetlands in 2014. Figure from Champness and Taylor 2015

**Heatherton Road South**



**Figure 62 MDS plot for Heatherton Road South Constructed Wetlands using standardised count data**

**Table 29 Summary of Heatherton Road South data used in the MDS**

	# species	Total Count (standardised)
2007	71	233
2008	85	238
2009	91	243
2010	81	288
2011	91	281
2012	79	296
2013	83	363
2014	81	319
2015	76	346
2016	80	459
2017	67	358

Heatherton Road South shows a similar distribution in years to Heatherton Valley North, with 2015-17 separate from the remaining years. For this site 2013 also shows differences in the avian community compared to other years. It is not immediately obvious in the bird trend data why 2013 is dis-similar to other years. As with Heatherton Road North, there is a decline in the abundance of more open water and deep water birds as well as those that use tall, dense reed or fringe vegetation (Appendix 5H).

## 5) Management

One of the major drivers of this monitoring project is to provide Melbourne Water with information to direct their on-ground management of sites; to retain or improve the ecological conditions of the site. With data now collected over five years a sound understanding of the bird communities current occurring at sites is available to allow Melbourne Water to assess their management against the requirements of the healthy waterways strategy.

The ecological processes that occur in wetlands are complex and highly dynamic. Periods of drying out, flooding and inundation and fluctuations in water levels are necessary to promote healthy ecosystems and habitats (see Kingsford 2000 for review of some of these processes). These different conditions are also necessary to retain the range of different bird species found in wetland habitats. Constructed wetlands are generally built for water management purposes – primarily to provide a measure of improving water quality, but can also have benefits to capture and store storm water run-off or to direct water flows away from infrastructure, with ecological benefits as secondary to their amenity purposes. Wetlands (constructed or otherwise) in urban spaces have additional social values (Boyer and Polasky 2004), making management of these sites more than just about water purification or nutrient retention.

Over the past 10 years bird surveys have been undertaken across 10 constructed wetlands in the Dandenong sub-catchment. Results presented here for five of those sites find that for many diving species (darters and cormorants) as well dabbling species (ducks and swans), abundances are declining. This may indicate increasing silt levels in the sites, reducing water depth or creating anaerobic conditions which lead to reductions in benthic invertebrates and aquatic vegetation (key food sources for a range of dabbling species). Loss of benthic vegetation and invertebrates may also be indicative of inappropriate inundation, and consideration of allowing these sites increased dry periods may be relevant. The bird data collected over the past decade provides Melbourne Water with unique opportunity to implement experimental testing of their on-ground management.

Going forward, the bird monitoring data and continuation of the MWrbm project can be used strategically by Melbourne Water to develop effective, best practice and tailored works practices. This is already occurring across a number of sites, for a range of high conservation values bird species. These species and the sympathetic management are summarized in Table 30. These activities undoubtedly benefit a range of bird species – particularly those around inundation and draw downs in tidal zones and the ongoing benefits to a range of both migratory and resident wader species. Melbourne Water should be commended for their current management practices that are designed to benefit these species. However, the lack of systematic data collection around management and on-ground works away from these high conservation species makes it difficult to test changes in bird communities against any of the current management practices. Improved record keeping of when works are carried out and over what area may help in determining the outcomes for the birds using these managed sites and improve and develop innovative management practices into the future.

**Table 30 Summary of management actions undertaken by Melbourne Water for priority conservation bird species**

Common Name	EPBC listing	Habitat preference (EVC)	Catchments of significance	sympathetic management undertaken	Species notes
Orange-bellied Parrot	CR	9, 10, 140, 196	<ul style="list-style-type: none"> <li>Werribee</li> <li>Westernport</li> </ul>	<ul style="list-style-type: none"> <li>saltmarsh restoration.</li> <li>Selective slashing of agricultural weeds.</li> <li>Track closures.</li> <li>April-October</li> </ul>	Melbourne Water manages the most significant wintering habitats for the species. Works undertaken by Melbourne Water to optimise habitat have been critical in the species survival.
Curlew Sandpiper	CR	9, 10, 653, 136	<ul style="list-style-type: none"> <li>Dandenong</li> <li>Werribee</li> <li>Westernport</li> </ul>	<ul style="list-style-type: none"> <li>draw downs in non-tidal wetlands &lt;5cm</li> <li>September-March</li> </ul>	Supratidal habitats provide preferential feeding and roosting opportunities and are particularly important for the species in dry years (Clemens unpublished)
Eastern Curlew	CR	9, 10	<ul style="list-style-type: none"> <li>Werribee</li> <li>Westernport</li> </ul>	<ul style="list-style-type: none"> <li>Intertidal output to optimise benthos. September-March</li> </ul>	Eastern Curlew are a coastal obligates but may be impacted at coastal roost sites and indirectly by influences on intertidal benthos.
Swift Parrot	CR	15, 55, 15	<ul style="list-style-type: none"> <li>Yarra</li> <li>Westernport</li> </ul>	<ul style="list-style-type: none"> <li>Plantings of eucalypt species including Spotted Gum, Red Ironbark and box species.</li> <li>Environmental flows</li> </ul>	The species is highly dispersive and only occurs on Melbourne Water properties in low densities. Foraging distribution on the mainland is highly dependent on flowering of eucalypt species.
Great Knot	CR	9, 10	<ul style="list-style-type: none"> <li>Werribee</li> </ul>	<ul style="list-style-type: none"> <li>Intertidal output to optimise benthos. September-March</li> </ul>	Great Knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. It is now absent from some sites along the south coast where it used to be a regular visitor (Garnett et al. 2011). The species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats.
Australasian Bittern	EN	656, 959,136,821	<ul style="list-style-type: none"> <li>Dandenong</li> <li>Werribee</li> <li>Westernport</li> </ul>	<ul style="list-style-type: none"> <li>Inundation of tall marsh</li> </ul>	Melbourne Water manages some of the most significant wintering habitats for the species.
Red Knot	EN	9, 10	<ul style="list-style-type: none"> <li>Werribee</li> </ul>	<ul style="list-style-type: none"> <li>Intertidal output to optimise benthos. September-March</li> </ul>	Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts. Numbers in Victoria have shown a marked decline (SPRAT)
Australian Painted Snipe	EN	104, 291,653,961	<ul style="list-style-type: none"> <li>Werribee</li> </ul>	<ul style="list-style-type: none"> <li>Maintain draw downs and emergent vegetation</li> </ul>	Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds.
Fairy Tern	VU	NA	<ul style="list-style-type: none"> <li>Werribee</li> </ul>	<ul style="list-style-type: none"> <li>Continued management of pest animals and predation risks</li> </ul>	Fairy Tern are coastal obligate although may roost or feed in near coastal supratidal ponds such as treatment plants or salt works.
Black-tailed Godwit	VU	9, 10, 653, 136	<ul style="list-style-type: none"> <li>Werribee</li> </ul>	<ul style="list-style-type: none"> <li>draw downs in non-tidal wetlands &lt;15cm</li> <li>September-March</li> </ul>	The Black-tailed Godwit forages on wide intertidal mudflats or sandflats, in soft mud or shallow water and occasionally in shallow estuaries. They use similar habitats on shores of inland lakes and other wetlands. They are found in muddy areas often open and unvegetated, but commonly use drying marshy wetlands

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## Appendix 1 Bird species used by Steele (2011) to develop ecological condition sub-index.

### Riparian Species

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Australasian Darter	<i>Anhinga novaehollandiae</i>	Brush Cuckoo	<i>Cacomantis variolosus</i>	Golden Whistler	<i>Pachycephala pectoralis</i>
Australian Hobby	<i>Falco longipennis</i>	Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>	Golden-headed Cisticola	<i>Cisticola exilis</i>
Australian Magpie	<i>Cracticus tibicen</i>	Common Bronzewing	<i>Phaps chalcoptera</i>	Grey Butcherbird	<i>Cracticus torquatus</i>
Australian Raven	<i>Corvus coronoides</i>	Crescent Honeyeater	<i>Phylidonyris pyrrhopterus</i>	Grey Currawong	<i>Strepera versicolor</i>
Australian Reed-Warbler	<i>Acrocephalus australis</i>	Crested Shrike-tit	<i>Falcunculus frontatus</i>	Grey Fantail	<i>Rhipidura albiscapa</i>
Australian Wood Duck	<i>Chenonetta jubata</i>	Crimson Rosella	<i>Platycercus elegans</i>	Grey Shrike-thrush	<i>Colluricincla harmonica</i>
Azure Kingfisher	<i>Ceyx azureus</i>	Dusky Moorhen	<i>Gallinula tenebrosa</i>	Large-billed Scrubwren	<i>Sericornis magnirostra</i>
Bassian Thrush	<i>Zoothera lunulata</i>	Dusky Woodswallow	<i>Artamus cyanopterus</i>	Latham's Snipe	<i>Gallinago hardwickii</i>
Bell Miner	<i>Manorina melanophrys</i>	Eastern Rosella	<i>Platycercus eximius</i>	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	Little Corella	<i>Cacatua sanguinea</i>
Black-fronted Dotterel	<i>Elseyornis melanops</i>	Eastern Whipbird	<i>Psophodes olivaceus</i>	Little Grassbird	<i>Megalurus gramineus</i>
Black-tailed Native Hen	<i>Gallinula ventralis</i>	Eastern Yellow Robin	<i>Eopsaltria australis</i>	Little Lorikeet	<i>Glossopsitta pusilla</i>
Brown Goshawk	<i>Accipiter fasciatus</i>	Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
Brown Thornbill	<i>Acanthiza pusilla</i>	Flame Robin	<i>Petroica phoenicea</i>	Little Raven	<i>Corvus mellori</i>
Brown Treecreeper	<i>Climacteris picumnus</i>	Fuscous Honeyeater	<i>Lichenostomus fuscus</i>	Long-billed Corella	<i>Cacatua tenuirostris</i>
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	Galah	<i>Eolophus roseicapillus</i>	Magpie-lark	<i>Grallina cyanoleuca</i>
Brush Bronzewing	<i>Phaps elegans</i>	Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Mistletoebird	<i>Dicaeum hirundinaceum</i>
Musk Lorikeet	<i>Glossopsitta concinna</i>	Red-rumped Parrot	<i>Psephotus haematonotus</i>	Tawny Frogmouth	<i>Podargus strigoides</i>
Nankeen Night-Heron	<i>Nycticorax caledonicus</i>	Restless Flycatcher	<i>Myiagra inquieta</i>	Tree Martin	<i>Petrochelidon nigricans</i>
Noisy Friarbird	<i>Philemon corniculatus</i>	Rose Robin	<i>Petroica rosea</i>	Varied Sittella	<i>Daphoenositta chrysoptera</i>
Olive Whistler	<i>Pachycephala olivacea</i>	Rufous Fantail	<i>Rhipidura rufifrons</i>	Wedge-tailed Eagle	<i>Aquila audax</i>
Olive-backed Oriole	<i>Oriolus sagittatus</i>	Rufous Songlark	<i>Cincloramphus mathewsi</i>	Welcome Swallow	<i>Hirundo neoxena</i>
Pacific Black Duck	<i>Anas superciliosa</i>	Rufous Whistler	<i>Pachycephala rufiventris</i>	Whistling Kite	<i>Haliastur sphenurus</i>
Painted Button-quail	<i>Turnix varius</i>	Sacred Kingfisher	<i>Todiramphus sanctus</i>	White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>
Pallid Cuckoo	<i>Cacomantis pallidus</i>	Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	White-browed Babbler	<i>Pomatostomus superciliosus</i>
Peregrine Falcon	<i>Falco peregrinus</i>	Satin Flycatcher	<i>Myiagra cyanoleuca</i>	White-browed Scrubwren	<i>Sericornis frontalis</i>
Pied Currawong	<i>Strepera graculina</i>	Shining Bronze-Cuckoo	<i>Chalcites lucidus</i>	White-eared Honeyeater	<i>Lichenostomus leucotis</i>
Pilotbird	<i>Pycnoptilus floccosus</i>	Silvereye	<i>Zosterops lateralis</i>	White-faced Heron	<i>Egretta novaehollandiae</i>
Pink Robin	<i>Petroica rodinogaster</i>	Southern Boobook	<i>Ninox novaeseelandiae</i>	White-naped Honeyeater	<i>Melithreptus lunatus</i>
Powerful Owl	<i>Ninox strenua</i>	Southern Emu-wren	<i>Stipiturus malachurus</i>	White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>
Purple Swamphen	<i>Porphyrio porphyrio</i>	Spotted Pardalote	<i>Pardalotus punctatus</i>	White-throated Nightjar	<i>Eurostopodus mystacalis</i>
Rainbow Bee-eater	<i>Merops ornatus</i>	Striated Pardalote	<i>Pardalotus striatus</i>	White-throated Treecreeper	<i>Cormobates leucophaea</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	Striated Thornbill	<i>Acanthiza lineata</i>	White-winged Chough	<i>Corcorax melanorhamphos</i>
Red Wattlebird	<i>Anthochaera carunculata</i>	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	White-winged Triller	<i>Lalage sueurii</i>
Red-browed Finch	<i>Neochmia temporalis</i>	Superb Fairy-wren	<i>Malurus cyaneus</i>	Willie Wagtail	<i>Rhipidura leucophrys</i>
Red-browed Treecreeper	<i>Climacteris erythrops</i>	Superb Lyrebird	<i>Menura novaehollandiae</i>	Yellow Thornbill	<i>Acanthiza hana</i>
Red-capped Robin	<i>Petroica goodenovii</i>	Swift Parrot	<i>Lathamus discolor</i>	Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>				
Yellow-tufted Honeyeater	<i>Lichenostomus melanops</i>				

## Wetland Species

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Australasian Bittern	<i>Botaurus poiciloptilus</i>	Eurasian Coot	<i>Fulica atra</i>	Pied Cormorant	<i>Phalacrocorax varius</i>
Australasian Darter	<i>Anhinga novaehollandiae</i>	Flame Robin	<i>Petroica phoenicea</i>	Pink-eared Duck	<i>Malacorhynchus membranaceus</i>
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	Golden-headed Cisticola	<i>Cisticola exilis</i>	Purple Swamphen	<i>Porphyrio porphyrio</i>
Australasian Shoveler	<i>Anas rhynchotis</i>	Great Cormorant	<i>Phalacrocorax carbo</i>	Red-kneed Dotterel	<i>Erythronyctes alba</i>
Australian Pelican	<i>Pelecanus conspicillatus</i>	Great Crested Grebe	<i>Podiceps cristatus</i>	Red-necked Stint	<i>Calidris ruficollis</i>
Australian Reed-Warbler	<i>Acrocephalus australis</i>	Grey Teal	<i>Anas gracilis</i>	Royal Spoonbill	<i>Platalea regia</i>
Australian Shelduck	<i>Tadorna tadornoides</i>	Hardhead	<i>Aythya australis</i>	Sharp-tailed Sandpiper	<i>Calidris acuminata</i>
Australian White Ibis	<i>Threskiornis moluccus</i>	Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>	Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Australian Wood Duck	<i>Chenonetta jubata</i>	Horsfield's Bushlark	<i>Mirafra javanica</i>	Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Baillon's Crake	<i>Porzana pusilla</i>	Horsfield's Bronze-Cuckoo	<i>Chalcites basalis</i>	Swamp Harrier	<i>Circus approximans</i>
Black Swan	<i>Cygnus atratus</i>	Intermediate Egret	<i>Ardea intermedia</i>	Welcome Swallow	<i>Hirundo neoxena</i>
Black-fronted Dotterel	<i>Elsayornis melanops</i>	Latham's Snipe	<i>Gallinago hardwickii</i>	Whiskered Tern	<i>Chlidonias hybrida</i>
Black-winged Stilt	<i>Himantopus leucocephalus</i>	Lewin's Rail	<i>Lewinia pectoralis</i>	Whistling Kite	<i>Haliastur sphenurus</i>
Blue-winged Parrot	<i>Neophema chrysostoma</i>	Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	White-faced Heron	<i>Egretta novaehollandiae</i>
Buff-banded Rail	<i>Gallirallus philippensis</i>	Little Grassbird	<i>Megalurus gramineus</i>	White-fronted Chat	<i>Epthianura albifrons</i>
Cape Barren Goose	<i>Cereopsis novaehollandiae</i>	Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	White-necked Heron	<i>Ardea pacifica</i>
Cattle Egret	<i>Ardea ibis</i>	Masked Lapwing	<i>Vanellus miles</i>	Yellow-billed Spoonbill	<i>Platalea flavipes</i>
Chestnut Teal	<i>Anas castanea</i>	Musk Duck	<i>Biziura lobata</i>		
Curlew Sandpiper	<i>Calidris ferruginea</i>	Nankeen Night-Heron	<i>Nycticorax caledonicus</i>		
Eastern Great Egret	<i>Ardea alba</i>	Pacific Black Duck	<i>Anas superciliosa</i>		

## Appendix 2 Shannon Diversity Scores Calculated for each MWrmb site

Site Name	Level	Total	2012-13	2013-14	2014-15	2015-16	2016-17
Bittern Reservoir	1	0.84				0.80	0.62
Boggy Creek, Carrum	1	3.17	2.99	3.15	3.09	3.08	
Boundary Road Wetland, Eel Race Drain, ETP	1	3.39	3.03	3.34	3.43	2.86	2.96
Braeside Park	1	3.61	3.62	3.53	3.40		3.14
Cheetham Saltfields (Parks Victoria)	1	3.21	2.21	3.29	3.05	3.12	3.00
Devilbend Reservoir	1	1.39	1.20	1.77	1.63	2.19	3.12
Eastern Treatment Plant	1	2.86	2.78	2.72	2.80	2.99	4.48
Edithvale - Zone 1	1	3.56	3.06	3.10	3.19	3.23	3.89
Edithvale - Zone 2	1	3.03	2.64	2.53	3.13	2.85	3.22
Edithvale - Zone 3	1	3.06	2.89	2.87	2.82	2.90	4.07
Edithvale - Zone 4	1	2.72	2.49	2.26	2.36	2.41	3.57
Edithvale - Zone 5	1	3.27	2.65	2.94	3.14	2.86	3.92
Edithvale - Zone 6	1	2.95	2.57	2.59	2.63	2.31	3.63
Edithvale - Zone 7	1	3.49	3.38	3.33	3.32	3.37	3.94
Edithvale - Zone 8	1	3.33	3.13	2.98	3.00	2.76	3.52
ETP south, Serpentine area	1	3.30		2.98	3.11		4.28
PARCS Wetland, Eel Race Drain, ETP	1	2.86	2.86	2.58	2.90	2.63	3.19
RAAF Lake	1	3.25		2.80	3.14	3.38	2.51
Seaford Wetlands - Zone 1	1	3.33	2.86	3.20	2.97	3.35	4.05
Seaford Wetlands - Zone 2	1	3.28	3.06	2.95	2.96	2.89	3.79
Seaford Wetlands - Zone 3	1	3.52	3.17	3.09	3.14	3.01	4.17
Seaford Wetlands - Zone 4	1	3.53	2.87	3.13	2.94	2.96	4.04
Seaford Wetlands - Zone 5	1	3.51	3.18	3.27	3.23	3.17	3.99
Seaford Wetlands - Zone 6	1	3.15	2.71	2.79	3.12	2.75	3.53
The Doughnut, Eastern Treatment Plant	1	3.24	2.39	3.18	3.26	2.84	3.95
Wannarkladdin Wetlands - east	1	3.44	2.94	2.76	3.31	2.96	3.58
Wannarkladdin Wetlands - north	1	3.19	2.25	2.97	2.59	2.76	3.61
Wannarkladdin Wetlands - west	1	3.41	2.83	3.21	3.06	3.19	3.85
WTP - 270S Borrow Pit	1	3.26	2.60	2.67	2.62	2.94	3.86
WTP - 35E Pond 8 Conservation Pond	1	3.09	2.42	2.03	2.13	2.83	3.33
WTP - 35E Pond 9 Conservation Pond	1	2.97	2.34	2.64	1.60	2.32	3.21
WTP - 5W Pond 10	1	3.36	2.01	2.72	2.42	2.66	3.45
WTP - 5W Pond 11	1	2.77	1.66	2.14	1.88	2.42	3.12
WTP - 5W Pond 9	1	3.19	2.38	2.84	2.54	1.47	3.11
WTP - 85WC Pond 9	1	2.88	2.54	1.04	2.26	2.14	3.62
WTP - Little River, Lower Reaches	1	3.45	2.61	2.76	2.48	2.72	3.87
WTP - Pond Q4	1	3.41		0.64	2.99	2.95	3.37
WTP - Summer Pond 1	1	3.00	2.49	1.90	2.52	2.34	3.18

Site Name	Level	Total	2012-13	2013-14	2014-15	2015-16	2016-17
WTP - Summer Pond 2	1	3.00	2.57	2.17	2.62	2.55	3.48
WTP - T Section Lagoon 1	1	1.92	1.87	1.27	1.85	0.52	3.02
WTP - T Section Lagoon 2	1	3.12	1.82	2.78	3.00	2.70	3.38
WTP - T Section Lagoon 3	1	3.39	2.53	3.15	3.09	2.11	3.35
WTP - T Section Lagoon 4	1	3.39		0	2.20	2.55	3.25
WTP - T Section Lagoon 5	1	2.94	2.40	1.96	2.36	2.37	2.63
WTP - T Section Lagoon 6	1	3.08	2.17	2.16	1.61	2.37	2.96
WTP - T Section Lagoon 7	1	3.11	2.39	2.25	2.16	2.80	2.80
WTP - Western Lagoon 3	1	3.14	2.23	2.52	1.71	1.82	2.94
WTP - Western Lagoon 6	1	3.04	2.09	1.57	2.11	2.30	2.76
WTP - Western Lagoon 7	1	2.80	2.05	2.49	2.22	1.85	2.62
WTP - Western Lagoon 8	1	2.71	2.14	2.27	1.85	1.04	2.47
WTP - Western Lagoon 9	1	3.03	2.47	2.46	2.14	2.64	2.76
WTP - Western Lagoon Ponds 4&5 (rehab)	1	2.21	1.54	1.31	2.56	3.14	2.01
Andersons Creek East Retarding Basin	2	3.37		3.31	3.25		
Birdsland, Monbulk Creek Retarding Basin	2	3.72		3.75	3.67	3.62	
Boggy Creek Waterway Reserve, Boggy Creek	2	3.23	2.60	3.20			
Cardinia Creek Retarding Basin, Cardinia Creek	2	2.97	2.68			1.92	
Cardinia Reservoir	2	3.79	3.45	3.75	3.71	2.47	
Cherry Lake north, Big Bend	2	3.47		2.44	2.56	3.18	3.04
Cherry Lake, Cherry Creek	2	3.22					
Colchester Road Retarding Basin, Bungalook Creek	2	3.26	2.45	2.59	2.60	2.94	3.00
Dunnetts Road Swamp, Plenty River	2	3.39	2.93	3.13	3.25	2.87	
ETP Rossiter Rd Lagoon (beside Banyun)	2	2.89	2.49326	2.42	2.95	2.73	3.86
ETP turf farm	2	3.41	2.85	2.94	2.84	3.08	4.06
Fussel Road Retarding Basin, Bungalook Creek	2	3.35	2.44	2.95	2.88	3.20	3.01
Galada Tamboore South, Merri Creek	2	3.50	3.19	2.90	3.24	3.24	3.29
Kororoit Creek Escarpments north, Kororoit Creek	2	2.83	2.60	2.71	2.35	2.63	
Kororoit Creek Escarpments south, Kororoit Creek	2	3.03	2.88	2.91	2.43	2.65	
Lakewood Park Res, Riddell Road Retarding Basin	2	3.31	2.93	3.31	3.24	3.15	3.25
Little Boggy Creek Retarding Basin	2	3.07	2.29	3.01			
Liverpool Road Retarding Basin, Dandenong Creek	2	3.72	3.32	3.43	3.00	3.64	3.37
Lower Kororoit Creek Waterway Reserve, Kororoit Creek	2	3.24	3.20	2.96			
Old Joes Creek Retarding Basin, Old Joes Creek	2	2.94	2.84	2.47			
Police Rd retarding basin Wetland	2	3.79		3.01	3.74	3.58	
Silvan Reservoir Park	2	3.98	2.63	2.89	3.41	1.94	3.01
Skeleton Creek Saltmarsh, Skeleton Creek	2	3.39	3.35	3.03	2.76	2.34	3.36
Tamarisk Waterway Reserve, Langwarrin	2	2.96		2.69		2.83	
The Inlets Waterway Reserve, Cardinia	2	3.76	3.06	3.30	3.44	3.60	4.19
Tirhatuan Wetlands, Dandenong Creek	2	3.72	2.81	3.34	3.29	3.47	3.81
Truganina Swamp, Laverton Creek	2	3.31	2.98	2.93	3.11	3.13	3.46

Site Name	Level	Total	2012-13	2013-14	2014-15	2015-16	2016-17
Tullamarine (Wright Street) retarding Basin,	2	3.55	3.00	3.31	2.83	2.85	3.78
Winton Wetlands	2	3.68	2.81	3.09	2.86	3.20	3.94
Yan Yean Reservoir Park	2	1.58	2.97	2.28	1.43	1.31	2.89
Yering Backswamp	2	3.63	3.30	3.69	3.42	3.11	
Bolin Bolin Billabong	3	3.20	3.38	2.90	3.18	2.63	2.71
Briars central trib	3	1.97		1.80	1.75		
Briars eastern trib	3	2.06		1.72	1.87		
Briars western trib	3	1.95					
Jacksons Creek Downstream Control	3	3.22		2.71	3.16	3.22	2.88
Jacksons Creek Works Site	3	3.42		3.24	3.37	3.05	3.21
Jawbone Reserve, Williamstown	3	3.08	2.89	2.49	2.86	3.29	3.51
Monbulk Creek Upstream Control	3	3.73		3.04	3.20	3.30	3.91
Monbulk Creek Works Site	3	3.56		2.68	3.20	2.82	3.50
Mullum Mullum Creek Currawong Park	3	3.01		2.91	2.94	2.95	3.07
Namatjira Wetlands, Clayton South	3	3.42	2.65	3.19	3.53	3.40	2.57
Olinda Creek, control	3	2.74		2.44	2.27	2.13	3.05
Olinda Creek, staged removal	3	3.12	2.16	2.77	2.56	2.57	3.06
Olinda Creek, Willow removed	3	3.07	2.10	2.93	2.68	2.56	3.18
Salt Creek, Rosanna Parklands	3	2.97		2.54	2.06	2.10	3.78
Werribee River Downstream Control	3	3.25		3.01	2.74		2.51
Werribee River Works Site	3	3.15		2.53	2.73		2.40
works evaluation - site 1	3	3.01		2.29	2.80	2.98	
works evaluation - site 10	3	3.74		1.29	3.21	3.15	3.22
works evaluation - site 13	3	3.85		2.28	2.76	3.08	3.63
works evaluation - site 14	3	3.70		2.20	2.81	2.96	3.44
works evaluation - site 15	3	3.72		2.72	3.05	3.04	3.20
works evaluation - site 16	3	2.71		0.53	2.19	2.37	2.67
works evaluation - site 2	3	3.48		3.00	3.37	3.17	
works evaluation - site 3	3	3.30		2.32	3.16	3.25	
works evaluation - site 4	3	2.37					
works evaluation - site 5	3	3.58		2.24	2.90	3.03	3.39
works evaluation - site 6	3	3.50		2.22	2.58	2.87	3.15
works evaluation - site 7	3	3.88		3.00	3.46	3.27	3.40
works evaluation - site 8	3	4.08		2.20	3.44	3.35	3.82
works evaluation - site 9	3	3.71		2.68	3.26	3.14	3.46
Ashwood - Queens Parade	4	3.17					
Berwick Springs wetlands	4	2.86	2.78	2.88	2.90	2.60	2.74
Cunningham Swamp North	4	2.81					
Cunningham Swamp South	4	2.83					
Dandenong Wetlands, Koomba Park	4	3.89	3.21	3.33	3.92	3.30	3.59
Darebin Parklands	4	3.28	2.98	3.13	2.76	3.33	3.02

Site Name	Level	Total	2012-13	2013-14	2014-15	2015-16	2016-17
Edithvale Common	4	2.82	2.81	2.07	1.69	1.74	3.30
Elsternwick Park	4	3.02	1.91	2.32	3.11	2.70	2.66
Fitzgerald Rd Grasslands & Andersons lake	4	2.66			1.29	2.02	2.64
Flemington Racecourse	4	3.18		2.69	3.08	2.91	3.12
Gardiners Ck - Station St to Burwood Hwy	4	3.42	1.52	2.51	2.80	2.90	3.88
Gisborne Swamp	4	3.16		2.07	2.96	3.12	2.72
Huntingdale Wetlands	4	3.00	1.66	3.30	3.69	3.71	2.21
Iramoo Wetlands	4	2.90		2.37	2.72	2.72	3.51
Jacana Wetlands (south)	4	3.37	3.03	2.98	3.27	2.93	2.91
Jancana Wetlands (north)	4	3.65	3.42	3.51	3.53	3.55	3.51
Jells Park Lake	4	3.75	2.42	3.53	3.72	3.35	3.50
Jingella Park - Gardiners Creek	4	3.46		2.75	3.43	2.82	2.35
Karkarook Park	4	3.13	3.47	2.32	3.61	3.00	3.19
Kayes Creek Waterway Reserve, Windsor Blvd	4	1.15			0.76	0.54	1.95
Kayes Creek Waterway Reserve, Yeend Crt Derrimut	4	2.91			1.33	1.90	2.48
Koo Wee Rup Tower	4	3.02	2.95	2.59			
Koomba Park North	4	3.73	2.14	3.52	3.38	3.16	3.77
Lakeside Dve Reserve	4	2.45	2.23	2.05	2.27	2.31	3.43
Leisureland Drive drain	4	2.30	2.31	1.83			
Market Garden Bend	4	3.35					
Moir Drive Reserve	4	3.16		2.86	2.83	2.88	2.99
Moonee Ponds Creek, Westmeadows	4	3.00	2.34	2.34	2.78	2.65	3.36
Mulgrave reserve wetland	4	3.53	1.95		3.25	2.96	3.66
Mullum Mullum Park	4	2.89	2.87	2.80			
Murunduka Swamp	4	3.66		3.17	3.50	3.00	3.03
Newport Lakes	4	3.44	3.33	3.30	3.15	3.12	3.50
Patterson Rlver	4	2.72		2.52	2.74	2.11	
PG- Marshland/Carex/Tortoise Pond	4	3.75		3.46	3.52	3.39	3.84
PG- Mother in Law's Leap	4	3.49		3.06	2.84	3.02	3.79
PG- North East Wetland	4	3.58		3.05	3.27	3.48	3.94
Powerline Easement	4	3.34				3.05	3.31
Ruffey Lake Park	4	3.55	3.02	3.32	2.90	3.09	4.00
Springvale rd Wetlands, Mordialloc Creek	4	3.81	3.76	3.74	3.80	3.66	3.58
Tootgarook Swamp - 92W	4	3.49		2.70	3.11	2.89	3.74
Tootgarook Swamp - A McNaughts lake	4	3.65	3.10	3.35	3.21	3.20	3.39
Tootgarook Swamp - C Moona swamp	4	2.44	2.08	1.93		2.20	
Tootgarook Swamp - D Moona swamp 2	4	2.76	1.89	2.13	2.70	2.08	
Tootgarook Swamp - Industrial estate RB	4	3.11		2.57	3.04	2.58	
Tootgarook Swamp - McNaught accumalitive	4	3.42	3.17	3.15	2.95	3.28	3.00
Tootgarook Swamp - MPS Tootgarook Wetland Reserve	4	3.48		2.92	3.46	2.99	
Tootgarook Swamp - Sanctuary Park Reserve	4	3.58		2.81	3.47	3.30	3.69

Site Name	Level	Total	2012-13	2013-14	2014-15	2015-16	2016-17
Tootgarook Swamp - Tern Ave Wetland	4	3.38		3.03	3.32	2.93	2.92
Tootgarook Swamp - Truemans Rd landfill	4	3.10		2.41	2.83	2.87	3.33
Tootgraook Swamp - B Gahnia swamp	4	3.23	2.68	3.03	2.53	2.74	
Trin Warren Tam-boore wetlands	4	3.62	2.57	3.44	3.43	3.49	3.79
Valley Lake Reserve	4	3.03	2.20	2.59	2.81	2.85	3.40
Valley Reserve retarding Basin, Waverly	4	3.46		2.22	3.26	3.29	3.26
Westbreen Creek - Gavin Park	4	3.00	1.48	2.26	2.34	2.36	2.83
Westbreen Creek - Joyce Reserve	4	2.84	1.70	1.86	2.45	2.02	2.87
Westgate Park	4	3.83	3.06	3.40	3.16	3.38	3.95
Williams Landing (Cedar Woods)	4	2.97	2.37	2.80	2.50	2.58	
Wintersun Crt Reserve	4	3.08	2.08	2.54	2.47	2.61	3.42
Woodlands Estate Wetlands	4	3.82	3.40	3.49	3.65	3.51	3.95
Woodlands Park, Essendon	4	3.09		2.64	2.69	2.49	3.32
Woods Reserve	4	3.95	3.66	3.42	3.33	3.48	4.07
Wurundjeri Walk, BlackburnSth	4	3.85	3.22	3.21	3.05	3.20	3.82
Yarran Dheran Reserve	4	3.22	0.94	1.41	2.88	3.10	2.73
Yaruk Tamboore	4	3.53		2.87	2.61	1.51	3.37
Frog Hollow Wetland, Eumemerring Creek	5	2.94	3.08	2.73	2.75	2.82	3.02
Golf Links Road	5	3.32	3.35	3.25	3.26	3.14	3.22
Hallam Valley Floodplain	5	3.57	3.54	2.90	3.50	3.50	3.46
Hallam Valley Floodplain, Troups Creek	5	3.06	3.41	2.96	2.89	2.88	2.63
Heatherton Road North	5	3.42	3.43	3.43	3.40	3.27	2.95
Heatherton Road South	5	3.39	3.36	3.34	3.36	3.00	3.15
Kilberry Boulevard, Hampton Park East Drain	5	3.42	3.31	3.39	3.27	3.32	3.32
Rigby's Wetland cell 1	5	2.88	2.59	2.61	2.38		2.90
Rigby's Wetland cell 2	5	3.08	2.65	2.99	2.86		2.94
Rigby's Wetland cell 3	5	3.63	2.62	2.96	3.66	3.63	3.71
Rigby's Wetland cell 4	5	2.93	2.65	2.77	3.11		2.81
River Gum Creek Reserve, Hampton Park East Drain	5	2.92	3.30	2.98	2.40	2.64	3.01
Troups Creek Narre Warren	5	3.54					
Waterford Wetlands, aka Karoo Road Wetland,	5	3.29	3.24	3.14	3.12	3.25	3.29

Appendix 3 Conservation Priority Species recorded across 2012-17 across MWRbm sites – Critically endangered CR, Endangered EN or Vulnerable VU Species

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curlew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper							
Berwick Springs wetlands		+													+		+						+																	+							
Birdsland, Monbulk Creek Retarding Basin									+																																			+			
Bittern Reservoir									+							+																															
Boggy Creek, Carrum	+	+			+											+																															
Bolin Bolin Billabong																+																															
Boundary Road Wetland, Eel Race Drain, ETP		+			+		+		+			+		+		+										+		+															+				
Braeside Park	+	+							+							+								+																							
Cardinia Reservoir						+														+																											
Cheetham Saltfields (Parks Victoria)	+	+					+	+	+	+	+	+		+	+	+	+				+					+	+	+																			
Cherry Lake north, Big Bend												+				+																															
Cherry Lake, Cherry Creek		+					+		+			+	+			+								+	+	+		+	+																		
Dandenong Wetlands, Koomba Park	+	+												+		+									+																						
Darebin Parklands		+																																													
Devilbend Reservoir		+							+			+				+								+																							
Duff's to Gully																																															



	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curlew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper							
Eastern Treatment Plant	+	+			+		+		+			+	+	+		+		+				+	+	+				+	+									+			+		+				
Edithvale - Zone 1	+	+														+																															
Edithvale - Zone 2	+	+	+		+				+			+		+		+		+						+	+																	+		+			
Edithvale - Zone 3	+				+											+																															
Edithvale - Zone 4									+							+													+																		
Edithvale - Zone 5	+	+	+		+											+							+						+																		
Edithvale - Zone 6	+															+							+						+																		
Edithvale - Zone 7	+	+			+				+					+		+		+						+					+												+		+		+		
Edithvale - Zone 8		+							+			+											+																								
Edithvale Common					+				+			+																													+	+					
Elsternwick Park																							+																								
ETP Rossiter Rd Lagoon (beside Banyun)		+										+		+		+		+							+			+														+	+	+			
ETP south, Serpentine area		+			+		+		+			+		+		+		+						+				+	+														+				
ETP turf farm	+	+										+		+		+		+						+	+					+																+	
Flemington Racecourse																+							+																								
Frog Hollow Wetland, Eumemerring Creek																+							+																								
Fussel Road Retarding Basin, Bungalook Creek																													+																		
Gardiners Ck - Station St to									+			+	+					+											+														+				

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curllew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper									
Burwood Hwy																																																	
Gisborne Swamp																									+																+								
Golf Links Road		+														+								+																									
Gongflers Peninsula																																				+													
Hallam Valley Floodplain	+															+								+																									
Hallam Valley Floodplain, Troups Creek	+	+	+		+											+								+		+																							
Heatherton Road North		+														+								+																									
Heatherton Road South					+											+																							+										
Heatherton Road South Wetland																+																																	
Huntingdale Wetlands																+								+	+																								
Iramoo Wetlands		+							+							+								+	+						+																		
Jacana Wetlands (south)																+								+																									
Jacksons Creek Downstream Control																									+																								
Jacksons Creek Works Site																									+																								
Jancana Wetlands (north)		+							+							+		+						+																									
Jawbone Reserve, Williamstown		+			+				+			+	+	+		+	+	+						+	+	+	+	+	+	+														+					
Jells Park Lake		+							+							+		+						+	+						+								+				+				+		
Karkarook Park		+	+		+		+	+	+			+				+		+						+	+		+				+							+	+			+							

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crane	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curling Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper													
Kilberry Boulevard, Hampton Park East Drain					+											+							+																														
Koo Wee Rup Tower																+																																					
Koomba Park North																+													+																								
Lakeside Dve Reserve																+		+						+																													
Lakewood Park Res, Riddell Road Retarding Basin		+							+							+		+										+																									
Liverpool Road Retarding Basin, Dandenong Creek Market Garden Bend		+			+				+							+							+	+	+																												
Moir Drive Reserve					+											+							+																														
Monbulk Creek Upstream Control												+																																									
Monbulk Creek Works Site																+																																					
Moonee Ponds Creek, Westmeadows		+																																																			
Murunduka Swamp																+																																					
Musso's																																																					
Namatjira Wetlands, Clayton South																																																					
Newport Lakes		+														+							+	+		+																											
Olinda Creek, control																																																					
Olinda Creek, staged removal											+																																										

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curllew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper								
Olinda Creek, Willow removed		+										+																+																				
PARCS Wetland, Eel Race Drain, ETP	+	+			+					+						+																																
Patterson River												+				+						+							+																			
PG-Marshland/Carex/Tor toise Pond		+							+							+		+								+																						
PG- Mother in Law's Leap		+			+																		+						+																			
PG- North East Wetland		+						+		+	+					+		+					+						+													+						
Police Rd retarding basin Wetland																+																																
RAAF Lake							+						+		+																+																	
Racecourse Road Ford		+										+	+			+							+			+		+	+																			
Rigby's Wetland Cell 1		+			+								+		+								+																									
Rigby's Wetland Cell 2		+												+	+								+						+																			
Rigby's Wetland cell 3	+	+			+				+							+		+					+	+	+		+																					
Rigby's Wetland cell 4	+	+	+		+											+		+					+						+																			
River Gum Creek Reserve, Hampton Park East Drain		+			+				+							+							+																									
Ruffey Lake Park		+						+								+							+						+																			
Seaford Wetlands - Zone 1	+	+			+				+			+				+		+					+	+	+		+	+																				
Seaford Wetlands - Zone 2										+													+																									
Seaford Wetlands - Zone 3		+								+	+		+			+							+				+																					

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crane	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curllew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper													
Seaford Wetlands - Zone 4		+											+		+																																						
Seaford Wetlands - Zone 5																																																					
Seaford Wetlands - Zone 6																																																					
Silvan Reservoir Park																+																																					
Skeleton Creek Saltmarsh, Skeleton Creek		+										+				+		+										+																									
Springvale rd Wetlands, Mordialloc Creek		+														+		+																																			
The Doughnut, Eastern Treatment Plant		+					+		+		+					+		+																																			
The Inlets Waterway Reserve, Cardinia		+					+		+		+		+			+												+																									
Tirhatuan Wetlands, Dandenong Creek		+						+								+								+																													
Tootgarook Swamp - 92W	+								+							+																																					
Tootgarook Swamp - A McNaughts lake		+					+		+							+																																					
Tootgarook Swamp - D Moona swamp 2							+																																														
Tootgarook Swamp - Industrial estate RB																							+																														
Tootgarook Swamp - McNaught accumulative		+					+									+		+					+																														
Tootgarook Swamp - MPS Tootgarook Wetland Reserve		+														+							+																														
Tootgarook Swamp - Sanctuary Park Reserve	+						+									+									+																												

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curling Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper												
Tootgarook Swamp - Truemans Rd landfill	+														+							+																		+												
Tootgarook Swamp - B Gahnia swamp					+																			+																												
Trin Warren Tamboore wetlands		+							+			+				+						+			+														+						+							
Troupes Creek Narre Warren								+								+		+											+																							
Truganina Swamp, Laverton Creek	+	+		+	+		+					+		+		+		+	+			+	+	+	+	+		+											+													
Tullamarine (Wright Street) retarding Basin,		+																											+																							
Valley Lake Reserve																							+																													
Valley Reserve retarding Basin, Waverly																+							+																													
Wannarkladdin Wetlands - east		+							+							+							+																													
Wannarkladdin Wetlands - north		+							+																																											
Wannarkladdin Wetlands - west		+							+					+		+							+	+					+																							
Waterford Wetlands, aka Karoo Road Wetland,							+		+							+		+					+																													
Watsons Crk N of Bridge																				+				+																												
Werrabee River Works Site																+																																				
Westbreen Creek - Gavin Park		+																				+																														
Westgate Park		+			+				+					+		+		+					+	+																												
Williams Landing (Cedar Woods)	+	+			+											+							+	+																												

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curllew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper								
Wintersun Crt Reserve																							+																									
Winton Wetlands		+														+				+			+																									
Woodlands Estate Wetlands	+	+	+		+		+		+							+		+							+			+													+							
Woodlands Park, Essendon																																																
Woods Reserve												+				+									+																	+						
works evaluation - site 10		+							+																																							
works evaluation - site 13												+											+																									
works evaluation - site 2																																																
works evaluation - site 5																							+																									
works evaluation - site 6																+																																
works evaluation - site 7																+																																
works evaluation - site 8		+							+																																							
works evaluation - site 9		+							+			+				+																																
WTP - 270S Borrow Pit		+				+			+		+	+		+				+						+				+	+	+													+					
WTP - 35E Pond 8 Conservation Pond		+			+				+		+	+		+		+							+					+	+																	+		
WTP - 35E Pond 9 Conservation Pond		+			+				+			+		+		+							+					+	+																		+	
WTP - 5W Pond 10		+							+							+							+						+																			
WTP - 5W Pond 11									+			+											+					+			+																	
WTP - 5W Pond 9		+							+			+		+		+							+					+	+																			

	Australasian Bittern	Australasian Shoveler	Australian Little Bittern	Australian Painted Snipe	Baillon's Crake	Barking Owl	Black Falcon	Black-tailed Godwit	Blue-billed Duck	Broad-billed Sandpiper	Brolga	Common Greenshank	Common Sandpiper	Curlew Sandpiper	Eastern Curlew	Eastern Great Egret	Fairy Tern	Freckled Duck	Great Knot	Grey Goshawk	Grey Plover	Gull-billed Tern	Hardhead	Intermediate Egret	Lewin's Rail	Little Egret	Little Tern	Marsh Sandpiper	Musk Duck	Orange-bellied Parrot	Pacific Golden Plover	Powerful Owl	Red Knot	Red-chested Button-quail	Square-tailed Kite	Swift Parrot	Terek Sandpiper	White-bellied Sea-Eagle	White-throated Needletail	Wood Sandpiper									
WTP - 85WC Pond 9		+					+	+		+	+		+										+				+	+																					
WTP - Little River, Lower Reaches		+						+		+	+		+			+								+	+			+													+								
WTP - Pond Q4	+	+					+	+	+	+	+	+		+		+	+	+					+		+	+			+										+	+			+						
WTP - Summer Pond 1		+						+		+	+		+					+							+	+																							
WTP - Summer Pond 2		+						+		+	+		+			+		+							+	+															+								
WTP - T Section Lagoon 1		+						+								+							+					+																					
WTP - T Section Lagoon 2		+			+		+	+	+	+	+	+	+	+		+	+	+					+	+	+	+	+	+											+	+			+						
WTP - T Section Lagoon 3		+			+		+			+	+	+	+	+		+	+	+	+				+	+		+		+													+								
WTP - T Section Lagoon 4		+						+	+	+	+	+	+	+		+	+	+					+	+																									
WTP - T Section Lagoon 5		+					+	+			+	+	+	+		+		+					+				+	+																	+				
WTP - T Section Lagoon 6		+					+	+	+		+	+	+	+		+		+					+				+	+																					
WTP - T Section Lagoon 7		+					+	+		+	+	+	+	+		+		+					+				+	+																		+			
WTP - Western Lagoon 3		+						+		+	+	+	+	+											+		+	+																					
WTP - Western Lagoon 6										+	+	+	+	+		+							+				+																						
WTP - Western Lagoon 7		+														+							+																										
WTP - Western Lagoon 8										+	+	+	+	+		+							+				+	+																					
WTP - Western Lagoon 9		+								+	+	+	+	+		+							+				+	+																					
WTP - Western Lagoon Ponds 4&5 (rehab)								+		+	+	+	+	+	+	+	+					+			+	+	+																					+	



Near Threatened NT species

Berwick Springs wetlands	
	Azure Kingfisher
	Black-faced Cormorant
+	Caspian Tern
	Emu
+	Latham's Snipe
	Little Button-quail
	Long-toed Stint
	Magpie Goose
+	Nankeen Night-Heron
	Pacific Gull
	Pectoral Sandpiper
+	Pied Cormorant
+	Royal Spoonbill
	Sanderling
	Sooty Oystercatcher
	Spotted Harrier
	Whiskered Tern
	White-winged Black Tern

Wurundjeri Walk, BlackburnStH	Yan Yeon Reservoir Park	Yarran Dheran Reserve	Yaruk Tamboore	Yering Backswamp	
					Australasian Bittern
	+				Australasian Shoveler
					Australian Little Bittern
					Australian Painted Snipe
			+		Baillon's Crake
					Barking Owl
					Black Falcon
					Black-tailed Godwit
			+		Blue-billed Duck
					Broad-billed Sandpiper
					Brolga
					Common Greenshank
				+	Common Sandpiper
			+		Curlew Sandpiper
					Eastern Curlew
				+	Eastern Great Egret
					Fairy Tern
				+	Freckled Duck
					Great Knot
					Grey Goshawk
					Grey Plover
					Gull-billed Tern
			+		Hardhead
					Intermediate Egret
					Lewin's Rail
					Little Egret
					Little Tern
					Marsh Sandpiper
				+	Musk Duck
					Orange-bellied Parrot
					Pacific Golden Plover
					Powerful Owl
					Red Knot
					Red-chested Button-quail
					Square-tailed Kite
				+	Swift Parrot
					Terek Sandpiper
	+			+	White-bellied Sea-Eagle
					White-throated Needletail
					Wood Sandpiper

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Birdsland, Monbulk Creek Retarding Basin	+		+															
Bittern Reservoir													+					
Boggy Creek, Carrum					+			+		+			+			+	+	
Bolin Bolin Billabong	+								+			+						
Boundary Road Wetland, Eel Race Drain, ETP			+		+					+	+	+	+			+	+	
Braeside Park					+				+	+	+	+	+				+	
Cardinia Reservoir				+												+		
Cheetham Saltfields (Parks Victoria)	+	+	+						+	+		+	+		+	+	+	
Cherry Lake north, Big Bend												+	+				+	
Cherry Lake, Cherry Creek			+		+					+		+	+				+	
Dandenong Wetlands, Koomba Park					+			+	+		+	+	+				+	
Darebin Parklands													+					
Devilbend Reservoir			+		+				+			+	+				+	
Eastern Treatment Plant	+		+		+				+	+	+	+	+			+	+	+
Edithvale - Zone 1													+				+	
Edithvale - Zone 2			+		+			+	+	+	+	+	+			+	+	
Edithvale - Zone 3					+							+				+		
Edithvale - Zone 4													+					
Edithvale - Zone 5					+			+	+				+				+	
Edithvale - Zone 6										+			+					
Edithvale - Zone 7					+			+	+	+	+		+				+	
Edithvale - Zone 8					+			+				+	+				+	

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Edithvale Common					+													
Elsternwick Park									+									
ETP Rossiter Rd Lagoon (beside Banyun)											+		+				+	+
ETP south, Serpentine area					+								+				+	+
ETP turf farm					+					+	+	+	+			+	+	
Flemington Racecourse									+							+		
Frog Hollow Wetland, Eumemerring Creek			+						+			+	+					
Fussel Road Retarding Basin, Bungalook Creek					+													
Galada Tamboore South, Merri Creek									+				+					
Gardiners Ck - Station St to Burwood Hwy			+					+	+			+	+				+	
Gisborne Swamp					+													
Golf Links Road			+		+				+				+					
Hallam Valley Floodplain			+		+				+	+		+	+					
Hallam Valley Floodplain, Troups Creek			+		+				+	+		+	+			+		
Heatherton Road North					+				+				+			+		
Heatherton Road South					+				+				+			+		
Heatherton Road South Wetland													+					
Huntingdale Wetlands					+				+									
Iramoo Wetlands					+			+					+					
Jacana Wetlands (south)									+									
Jacksons Creek Downstream Control					+													
Jacksons Creek Works Site					+													

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Jancana Wetlands (north)					+				+				+					
Jawbone Reserve, Williamstown		+	+		+					+		+	+	+	+		+	
Jells Park Lake		+			+				+			+	+					
Karkarook Park			+		+				+	+		+	+				+	
Kilberry Boulevard, Hampton Park East Drain					+				+	+			+					
Koomba Park North					+				+									
Lakeside Dve Reserve												+						
Lakewood Park Res, Riddell Road Retarding Basin					+													
Leisureland Drive drain					+													
Liverpool Road Retarding Basin, Dandenong Creek					+								+					
Moir Drive Reserve												+						
Monbulk Creek Upstream Control												+						
Moonee Ponds Creek, Westmeadows													+					
Mulgrave reserve wetland									+									
Namatjira Wetlands, Clayton South									+	+								
Newport Lakes									+			+	+				+	
PARCS Wetland, Eel Race Drain, ETP												+	+				+	
Patterson River			+									+	+				+	
PG- Marshland/Carex/Tortoise Pond					+								+					
PG- Mother in Law's Leap					+													
PG- North East Wetland					+							+	+					

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Police Rd retarding basin Wetland					+				+			+	+					
RAAF Lake										+		+	+			+	+	
Racecourse Road Ford					+					+		+	+				+	
Rigby's Wetland Cell 1			+		+				+			+	+					
Rigby's Wetland Cell 2					+				+				+			+		
Rigby's Wetland cell 3			+		+				+	+		+	+				+	
Rigby's Wetland cell 4					+				+			+	+					
River Gum Creek Reserve, Hampton Park East Drain			+		+				+				+				+	
Ruffey Lake Park					+				+				+					
Seaford Wetlands - Zone 1			+		+		+			+	+	+	+				+	
Seaford Wetlands - Zone 2																	+	+
Seaford Wetlands - Zone 3																		+
Seaford Wetlands - Zone 4					+					+			+				+	
Seaford Wetlands - Zone 5					+					+			+					
Seaford Wetlands - Zone 6					+								+					
Skeleton Creek Saltmarsh, Skeleton Creek					+							+	+				+	
Springvale rd Wetlands, Mordialloc Creek			+		+			+	+	+		+	+			+	+	
The Doughnut, Eastern Treatment Plant					+					+			+			+	+	
The Inlets Waterway Reserve, Cardinia												+	+			+	+	
Tirhatuan Wetlands, Dandenong Creek					+							+	+					
Tootgarook Swamp - 92W										+			+					
Tootgarook Swamp - A McNaughts lake					+					+			+				+	

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Tootgarook Swamp - Industrial estate RB					+													
Tootgarook Swamp - McNaught accumalitive					+				+				+					
Tootgarook Swamp - MPS Tootgarook Wetland Reserve					+					+								
Tootgarook Swamp - Sanctuary Park Reserve					+				+	+		+	+			+		
Tootgarook Swamp - Tern Ave Wetland					+													
Tootgarook Swamp - Truemans Rd landfill					+								+			+		
Tootgraook Swamp - B Gahnia swamp													+					
Trin Warren Tam-boore wetlands									+	+		+	+					
Troupes Creek Narre Warren			+		+													
Truganina Swamp, Laverton Creek		+			+	+				+		+	+			+	+	
Tullamarine (Wright Street) retarding Basin,									+			+	+					
Valley Lake Reserve										+								
Valley Reserve retarding Basin, Waverly					+				+									
Wannarkladdin Wetlands - east			+									+	+				+	
Wannarkladdin Wetlands - north								+					+				+	
Wannarkladdin Wetlands - west					+							+	+				+	
Waterford Wetlands, aka Karoo Road Wetland,					+													
Westgate Park					+				+	+		+	+		+		+	
Williams Landing (Cedar Woods)												+	+			+	+	
Wintersun Crt Reserve													+					

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
Winton Wetlands					+							+						
Woodlands Estate Wetlands					+			+	+	+		+	+			+	+	
Woodlands Park, Essendon									+									
Woods Reserve			+		+							+	+					
works evaluation - site 13																	+	
works evaluation - site 14												+						
works evaluation - site 7					+				+				+				+	
works evaluation - site 8													+					
works evaluation - site 9													+					
WTP - 270S Borrow Pit										+		+	+			+	+	
WTP - 35E Pond 8 Conservation Pond												+	+				+	
WTP - 35E Pond 9 Conservation Pond												+					+	
WTP - 5W Pond 10												+					+	
WTP - 5W Pond 11					+												+	
WTP - 5W Pond 9																	+	
WTP - 85WC Pond 9																	+	
WTP - Little River, Lower Reaches			+		+							+	+			+	+	
WTP - Pond Q4			+		+				+	+	+	+	+			+	+	+
WTP - Summer Pond 1			+										+				+	
WTP - Summer Pond 2			+		+							+	+			+	+	
WTP - T Section Lagoon 1																	+	
WTP - T Section Lagoon 2											+	+	+			+	+	+

	Azure Kingfisher	Black-faced Cormorant	Caspian Tern	Emu	Latham's Snipe	Little Button-quail	Long-toed Stint	Magpie Goose	Nankeen Night-Heron	Pacific Gull	Pectoral Sandpiper	Pied Cormorant	Royal Spoonbill	Sanderling	Sooty Oystercatcher	Spotted Harrier	Whiskered Tern	White-winged Black Tern
WTP - T Section Lagoon 3		+					+	+		+		+	+			+	+	+
WTP - T Section Lagoon 4												+	+			+	+	+
WTP - T Section Lagoon 5											+	+	+			+	+	+
WTP - T Section Lagoon 6													+				+	
WTP - T Section Lagoon 7													+				+	+
WTP - Western Lagoon 3			+									+	+				+	
WTP - Western Lagoon 6																	+	
WTP - Western Lagoon 7													+				+	
WTP - Western Lagoon 8													+				+	
WTP - Western Lagoon 9													+			+	+	
WTP - Western Lagoon Ponds 4&5 (rehab)												+	+		+		+	
Wurundjeri Walk, BlackburnSth					+				+			+						+
Yan Yean Reservoir Park			+		+				+			+	+				+	
Yaruk Tamboore					+													



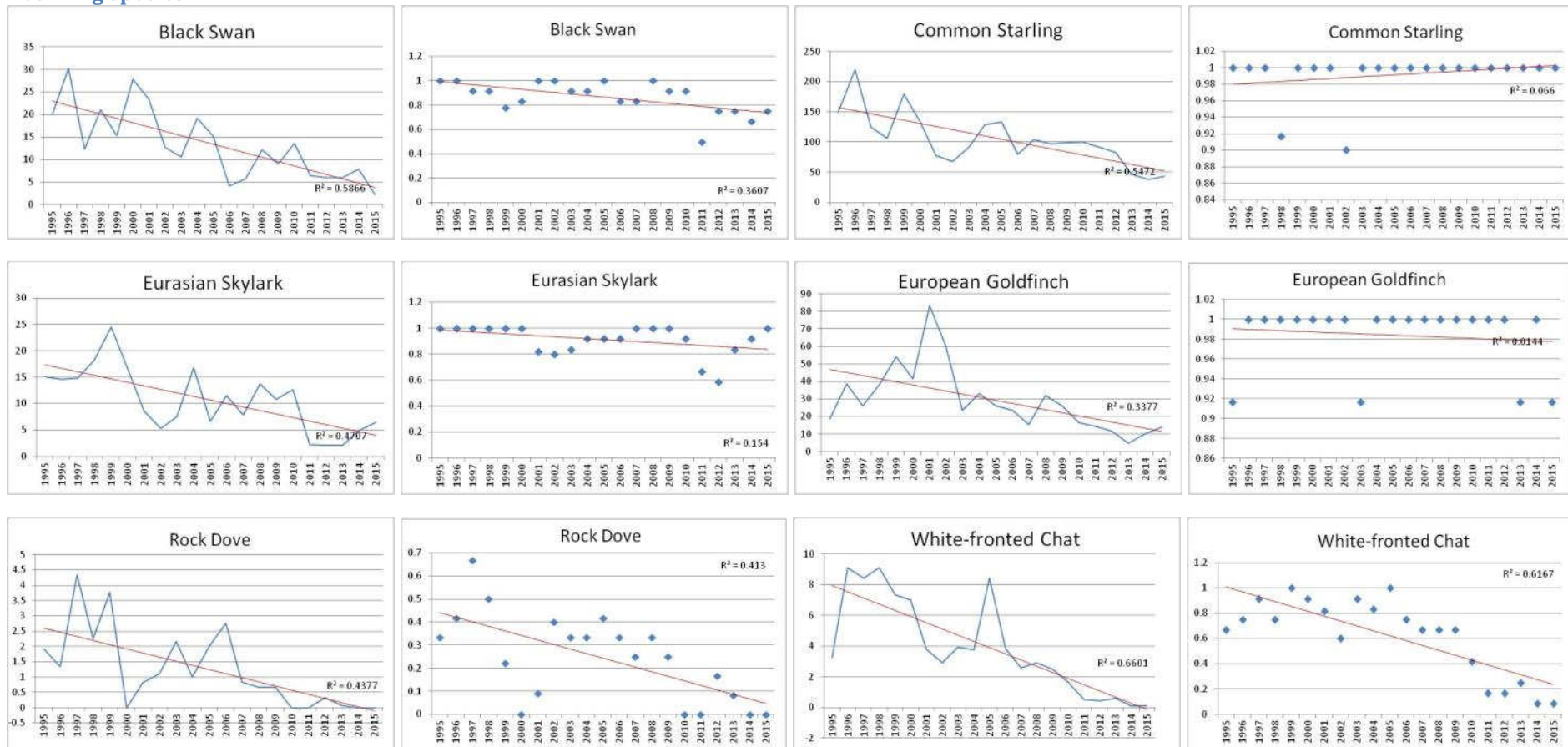
#### Appendix 4. Total counts of Latham's Snipe across MWrmb sites over 5 year monitoring period

Site Name	2012-13	2013-14	2014-15	2015-16	2016-17	Grand Total
Berwick Springs wetlands	67	6	9	1		83
Boggy Creek, Carrum		3	1	1		5
Boundary Road Wetland, Eel Race Drain, ETP	2	5	2		1	10
Braeside Park	10	7				17
Cherry Lake, Cherry Creek	4			1	1	6
Eastern Treatment Plant	28	57	33	41	19	178
Edithvale - Zone 1					1	1
Edithvale - Zone 2	10	11	27	10	3	61
Edithvale - Zone 3				3		3
Edithvale - Zone 5	2	1	3		5	11
Edithvale - Zone 7	3	97	105	77	70	352
Edithvale - Zone 8	61	1			1	63
Edithvale Common	4					4
ETP south, Serpentine area		2				2
ETP turf farm			6	9		15
Fitzgerald Rd Grasslands & Andersons lake	1					1
Gisborne Swamp			1		17	18
Golf Links Road	2	4	5		2	13
Greens Rd wetlands	0	1				1
Hallam Valley Floodplain	12		4			16
Hallam Valley Floodplain, Troups Creek	11	13	3		9	36
Heatherton Road North	6	14	11		4	35
Heatherton Road South	2	3				5
Huntingdale Wetlands			2			2
Jacksons Creek Downstream Control				1		1
Jacksons Creek Works Site			3		2	5
Jancana Wetlands (north)	2	3				5
Jawbone Reserve, Williamstown	2	2	6	1		11
Jells Park Lake		15	1			16
Karkarook Park	42	12	21	1		76
Kilberry Boulevard, Hampton Park East Drain	3	4			4	11
Lakewood Park Res, Riddell Road Retarding Basin	0	3	4			7
Leisureland Drive drain	1					1
Leisureland Drive Wetland	1					1
Liverpool Road Retarding Basin, Dandenong Creek		4	3			7
PARCS Wetland, Eel Race Drain, ETP	1				1	2
PG- Marshland/Carex/Tortoise Pond			9	2		11
PG- Mother in Law's Leap		1				1

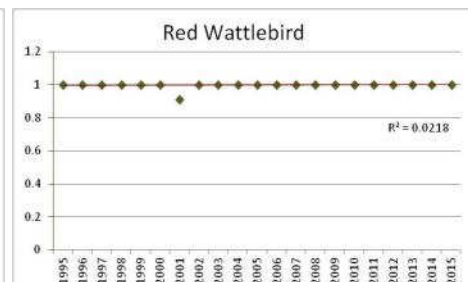
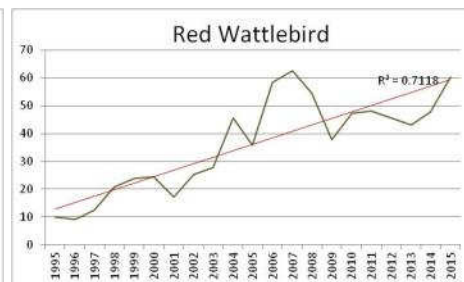
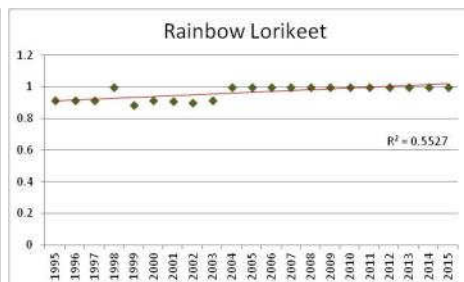
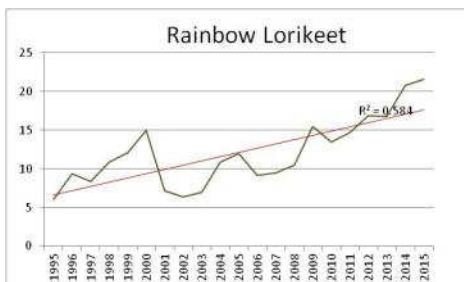
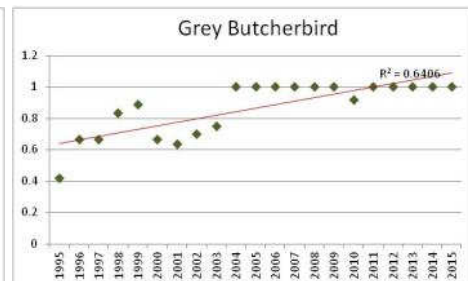
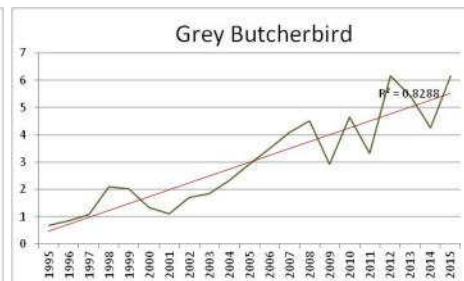
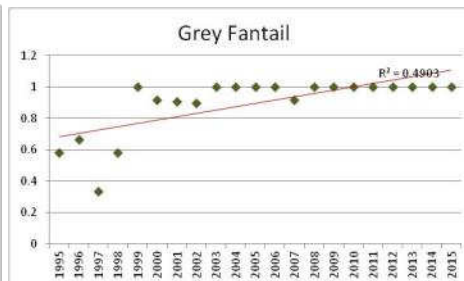
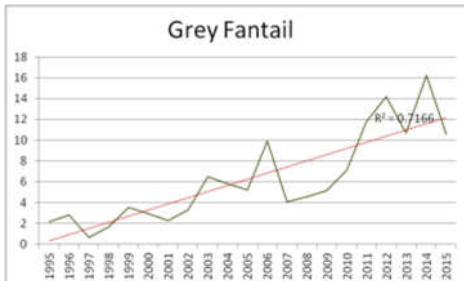
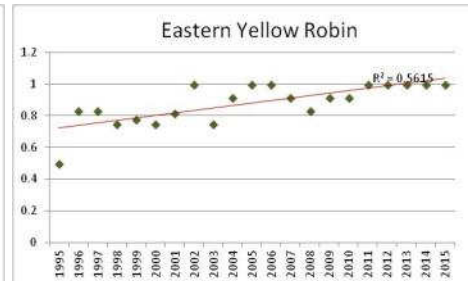
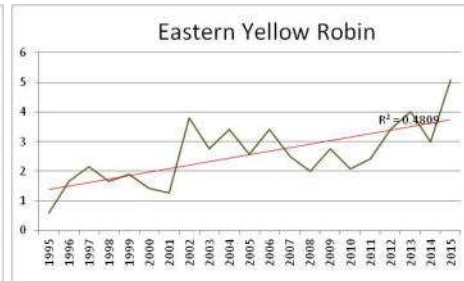
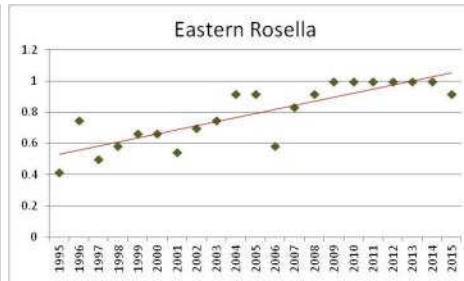
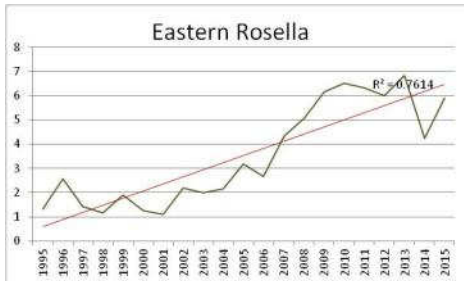
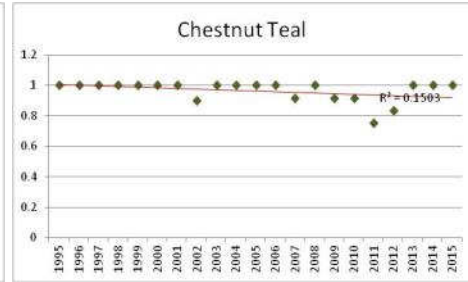
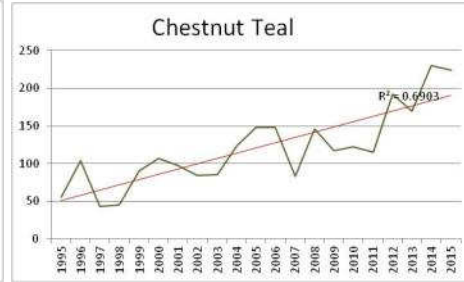
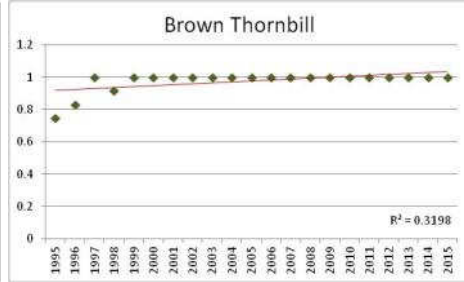
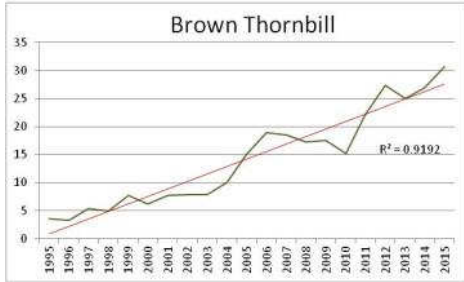
Site Name	2012-13	2013-14	2014-15	2015-16	2016-17	Grand Total
PG- North East Wetland		5			4	9
Police Rd retarding basin Wetland			1			1
Rigby's Wetland Cell 1		2				2
Rigby's Wetland cell 3	24		0		2	26
Rigby's Wetland cell 4		2	1			3
River Gum Creek Reserve, Hampton Park East Drain	8	16	6		16	46
Seaford Wetlands - Zone 1	63	80	74	22	47	286
Seaford Wetlands - Zone 4			1	1		2
Seaford Wetlands - Zone 5		1				1
Skeleton Creek Saltmarsh, Skeleton Creek		1		1		2
Springvale rd Wetlands, Mordiallock Creek	12	12	21			45
The Doughnut, Eastern Treatment Plant	57	29	28	13	6	133
Tirhatuan Wetlands, Dandenong Creek		19	23	14	3	59
Tootgarook Swamp - 92W	23	1				24
Tootgarook Swamp - A McNaughts lake		3				3
Tootgarook Swamp - Industrial estate RB				3		3
Tootgarook Swamp - McNaught accumalitive	1	1	2			4
Tootgarook Swamp - MPS Tootgarook Wetland Reserve				1		1
Tootgarook Swamp - Sanctuary Park Reserve			1			1
Tootgarook Swamp - Tern Ave Wetland			3			3
Tootgarook Swamp - Truemans Rd landfill		2				2
Troupes Creek Narre Warren	3					3
Truganina Swamp, Laverton Creek		2				2
Valley Reserve retarding Basin, Waverly			1			1
Wannarkladdin Wetlands - west	2	8	6	4	3	23
Waterford Wetlands, aka Karoo Road Wetland,	62	83	97	48	61	351
Westgate Park			1			1
Winton Wetlands	5					5
Woodlands Estate Wetlands	0	2	7	1		10
works evaluation - site 7			5	2		7
WTP - 270S Borrow Pit			1			1
WTP - Pond Q4				1		1
WTP - Summer Pond 2	1					1
Yan Yean Resevior Park			2			2
Yaruk Tamboore		1	1			2

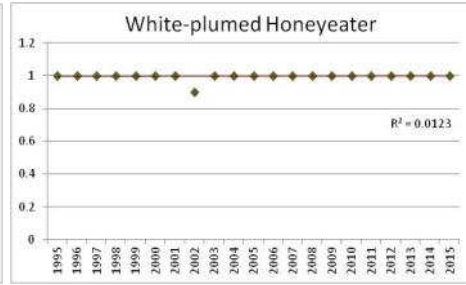
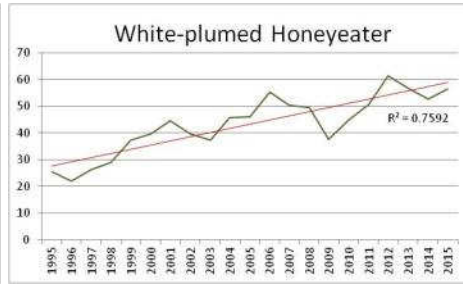
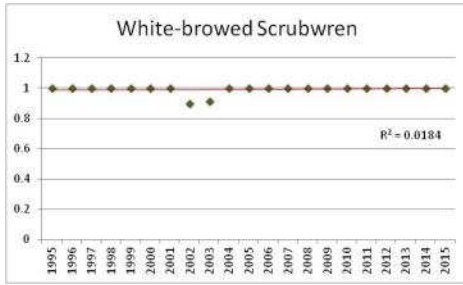
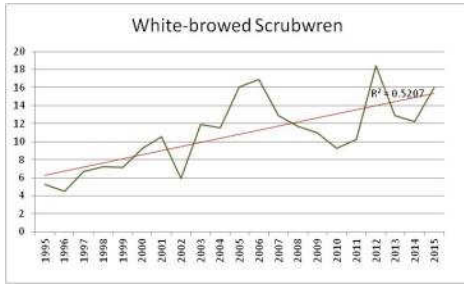
Appendix 5A Species Trends for Seaford figure on the left the standardised abundance data and the right being the reporting rate.

Declining Species

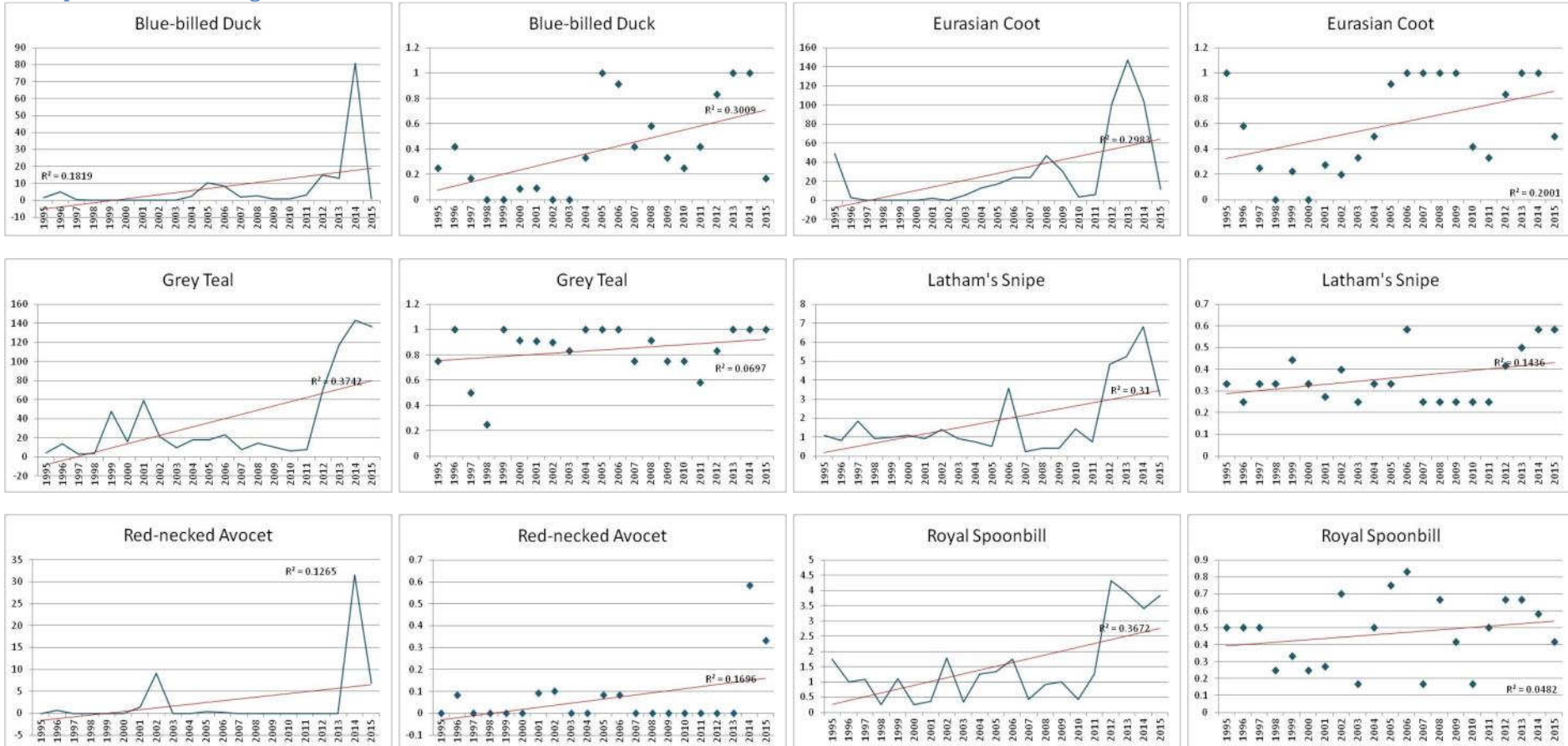


## Increasing Species





## Species contributing to MDS variation





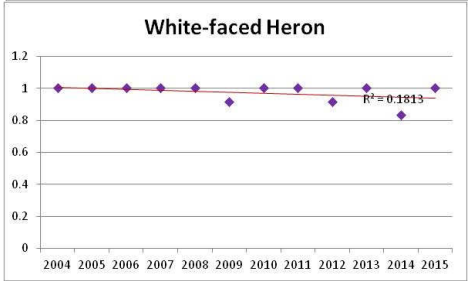
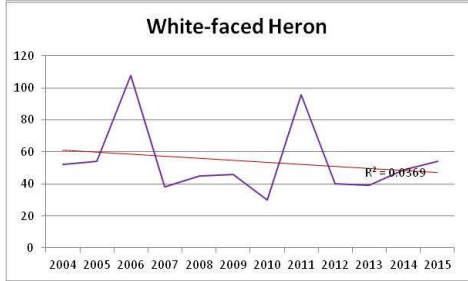
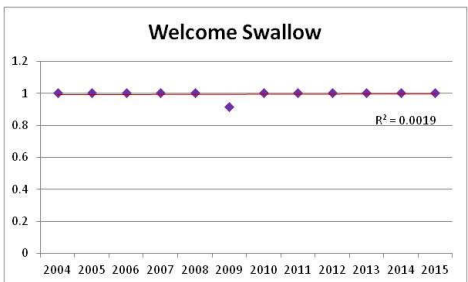
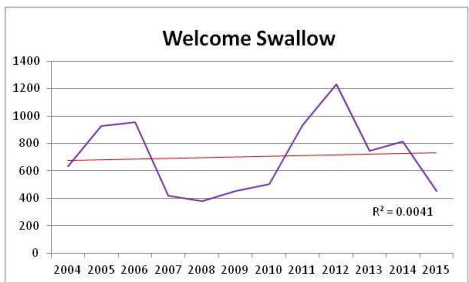
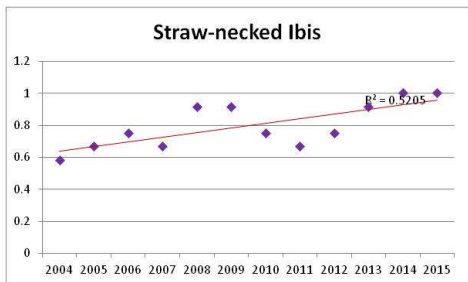
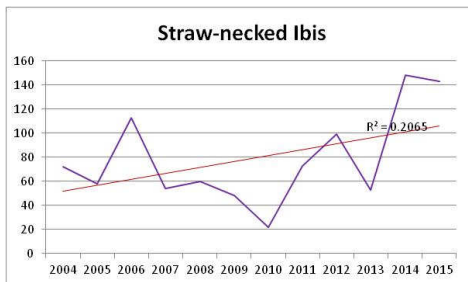
Appendix 5B: Species Trends for Edithvale. Figure on the left the abundance data and the right being the reporting rate.

Species contributing to MDS plot

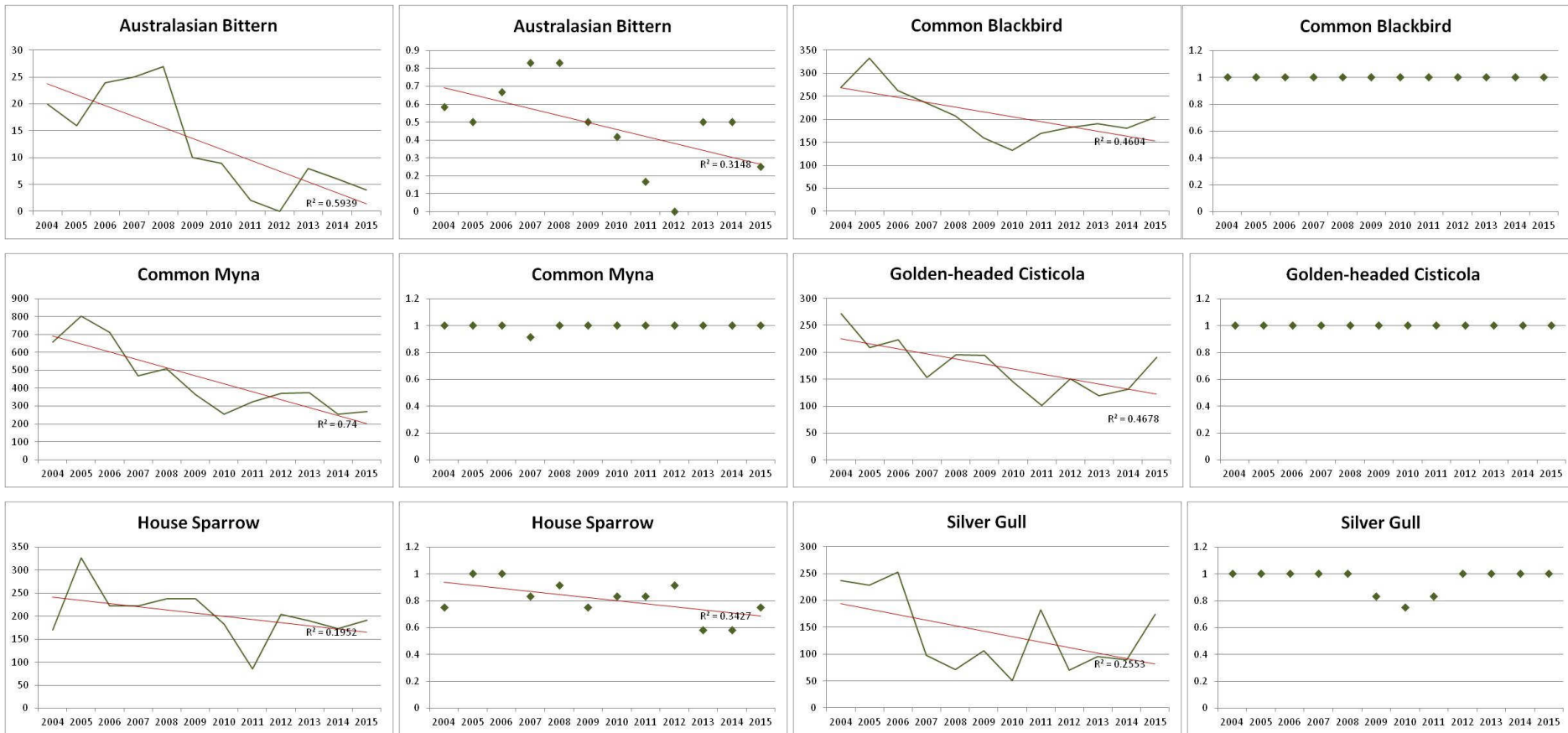




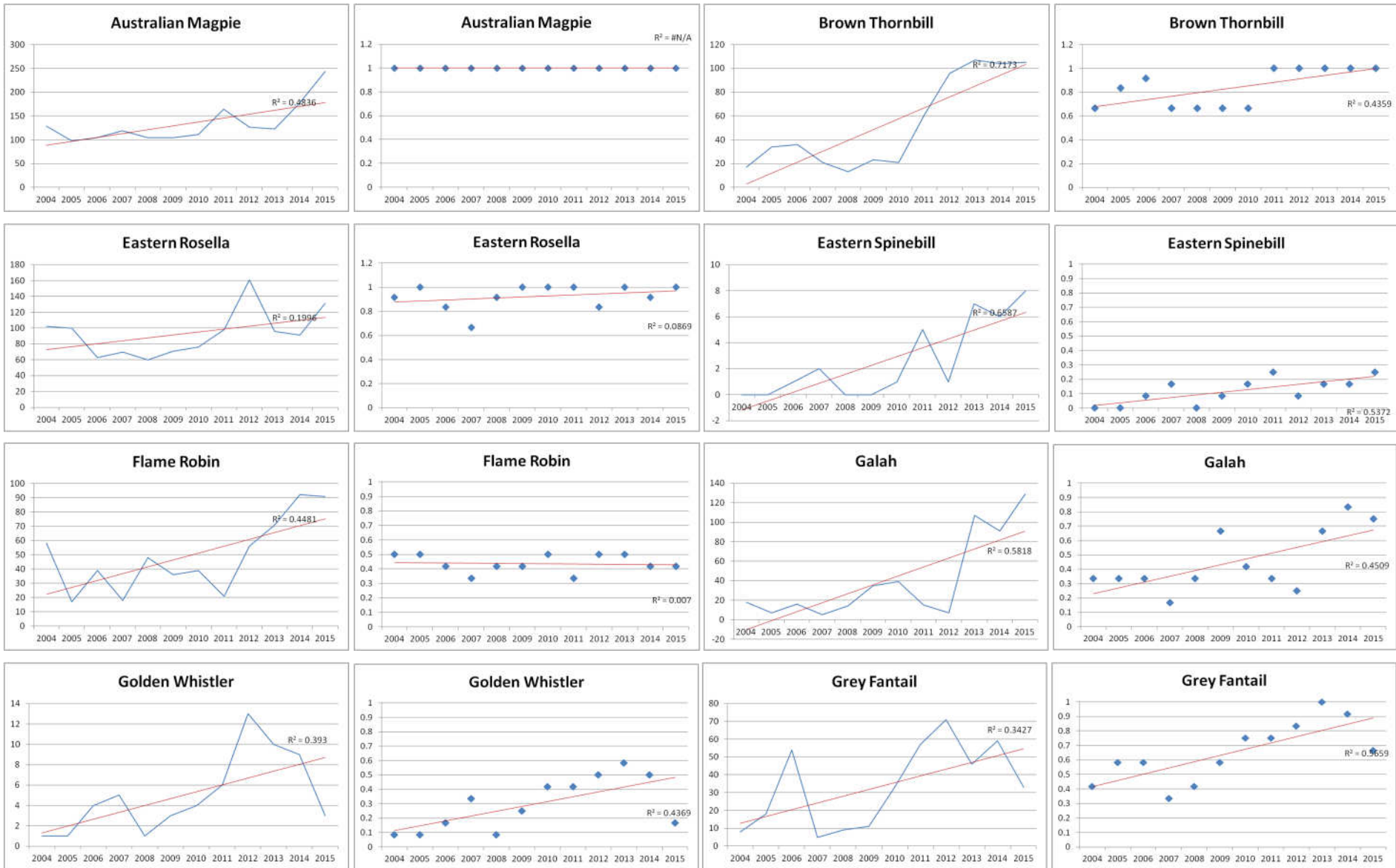


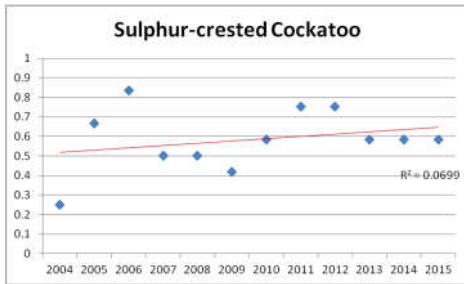
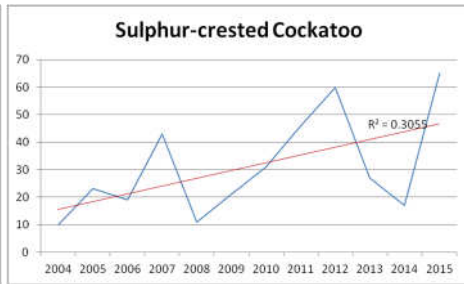
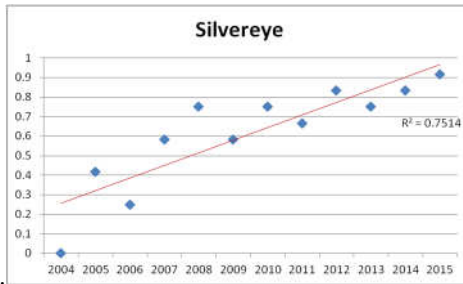
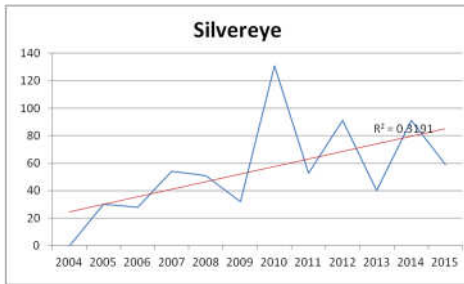
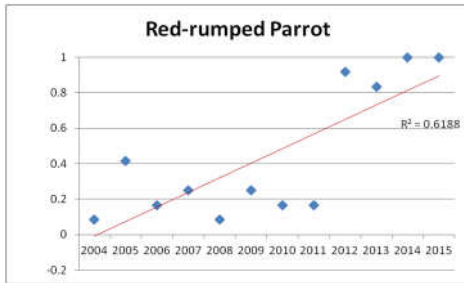
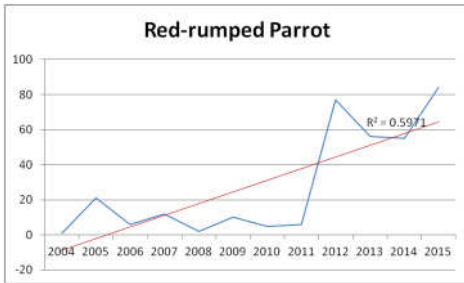
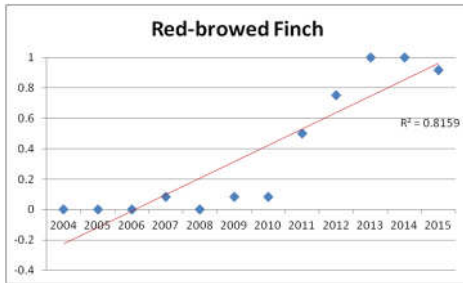
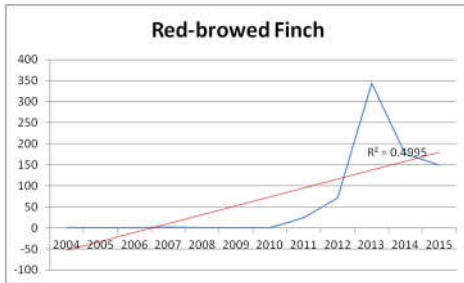
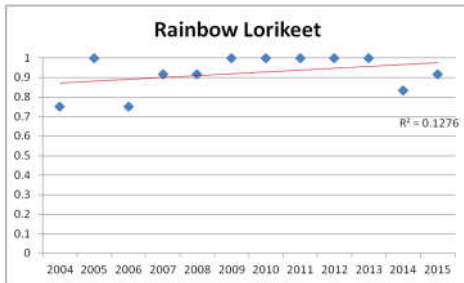
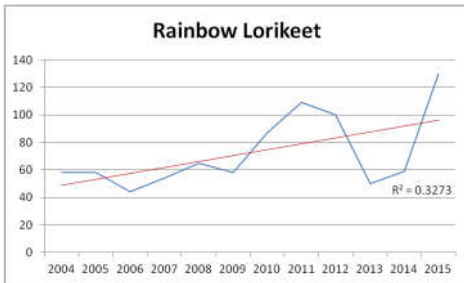
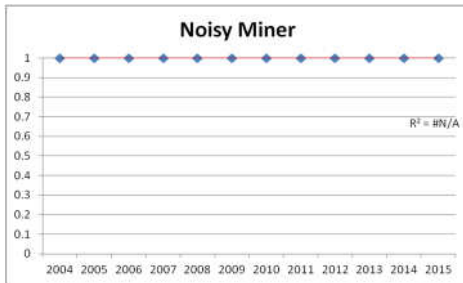
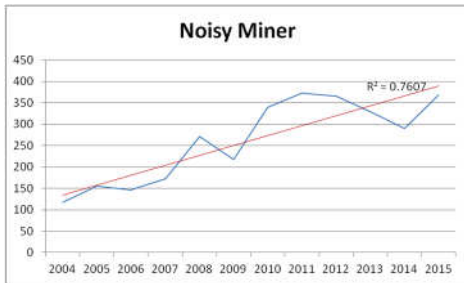
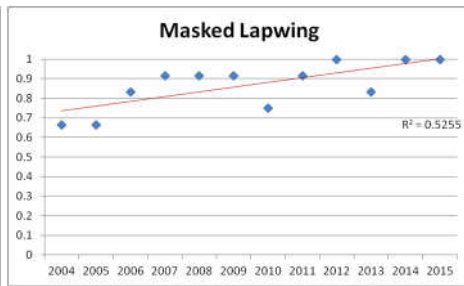
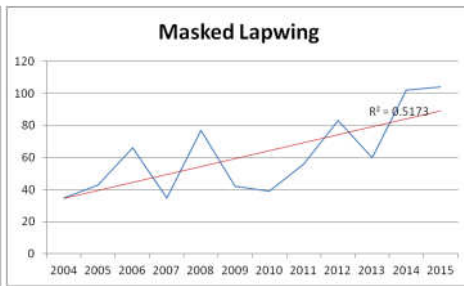
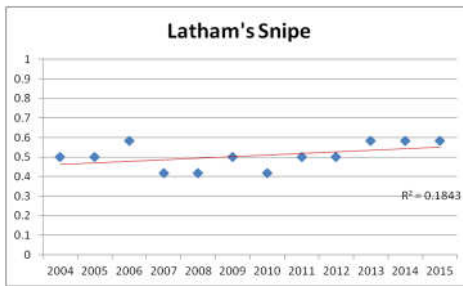
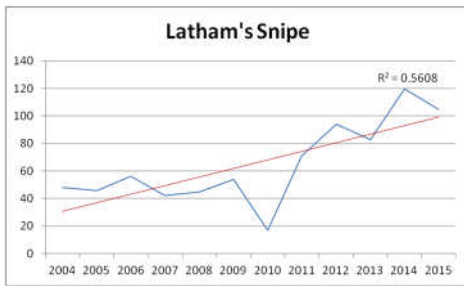


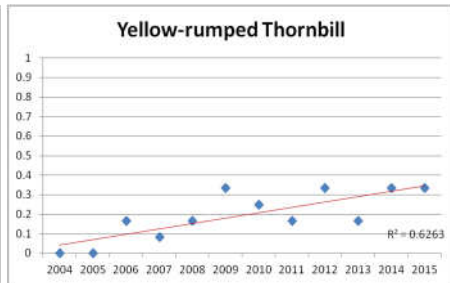
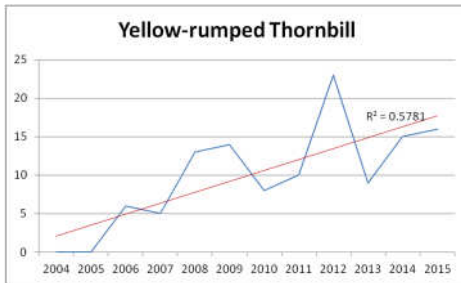
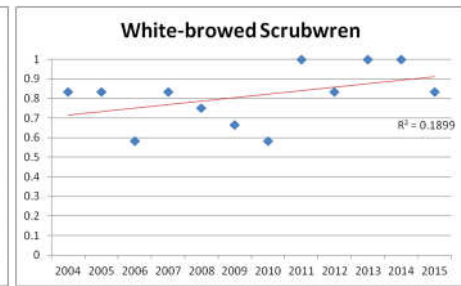
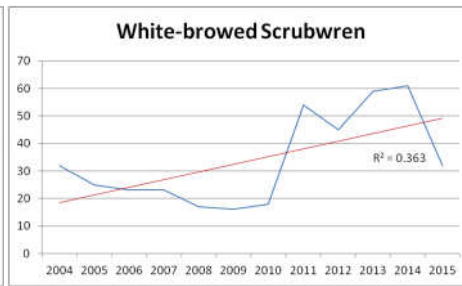
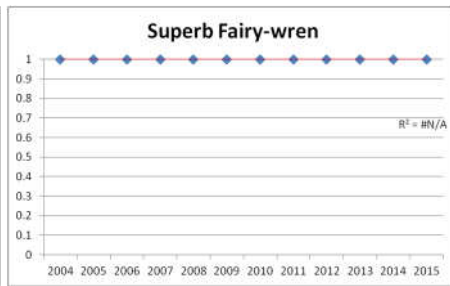
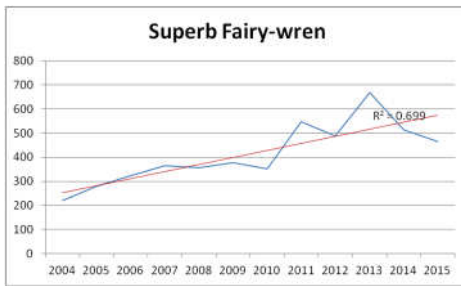
## Declining species



## Increasing Species

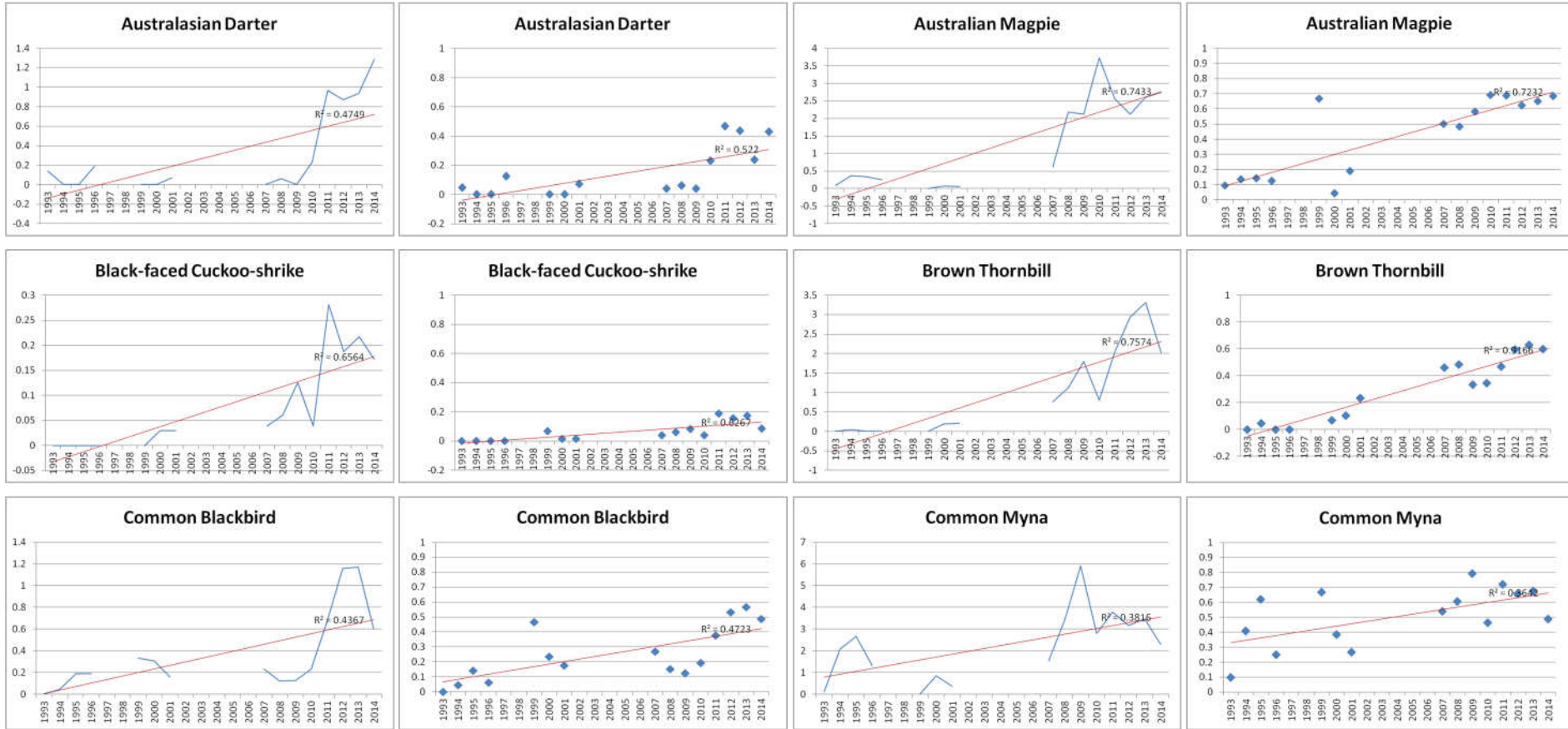




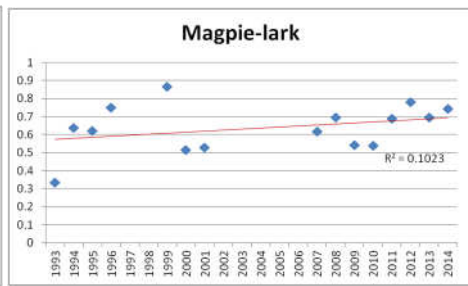
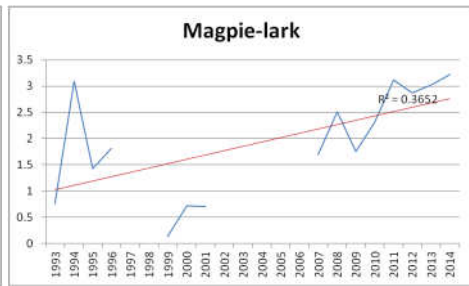
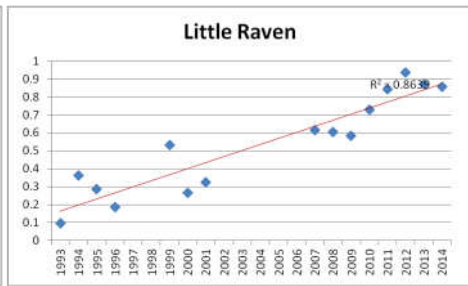
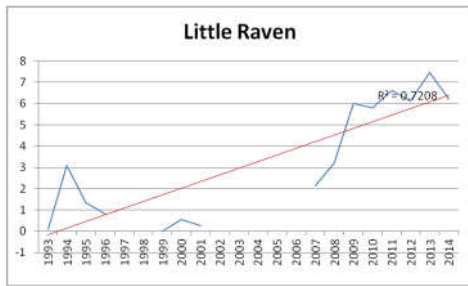
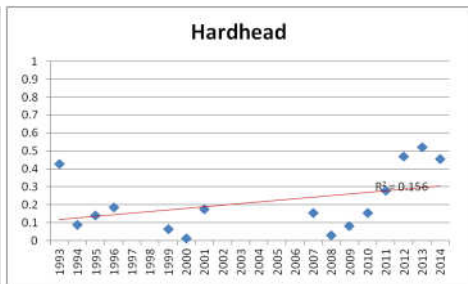
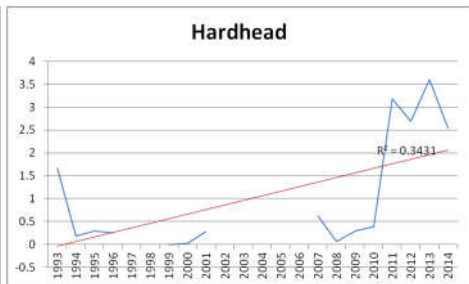
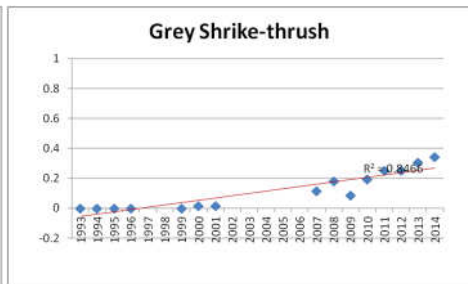
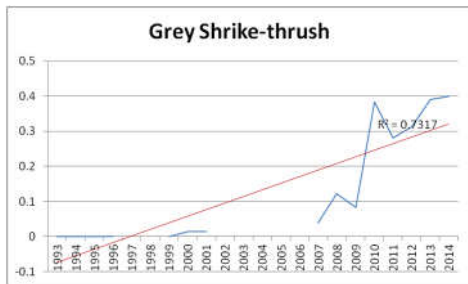
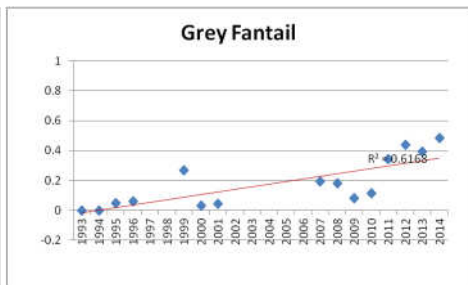
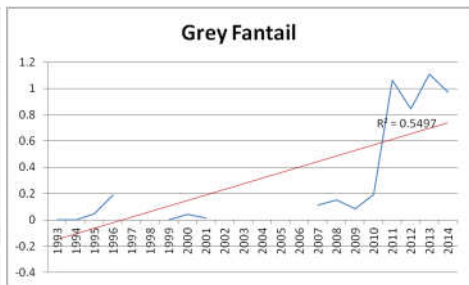
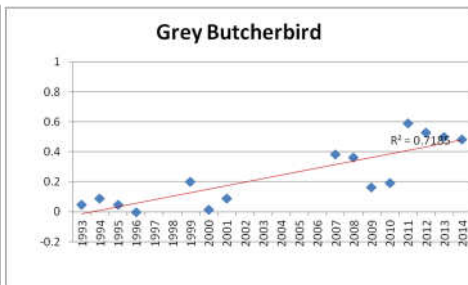
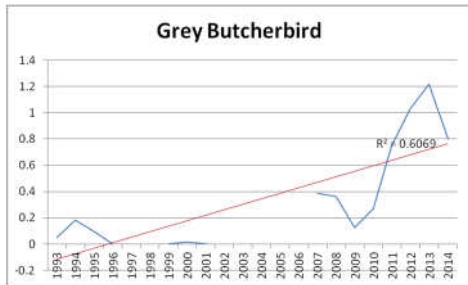
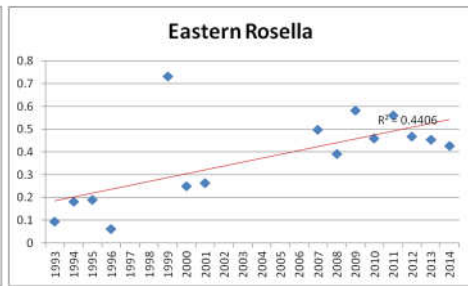
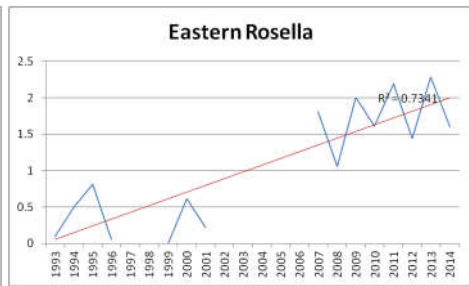
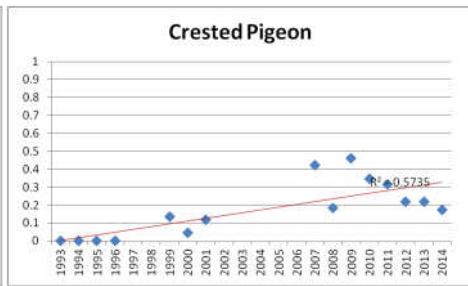
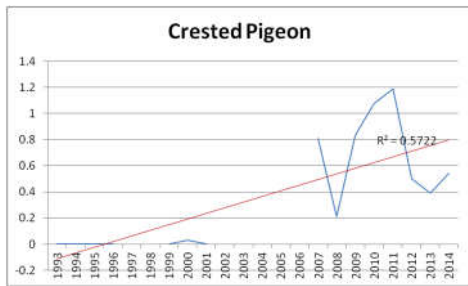


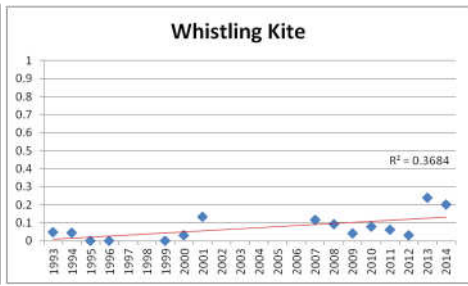
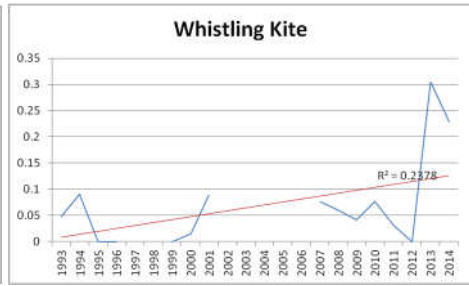
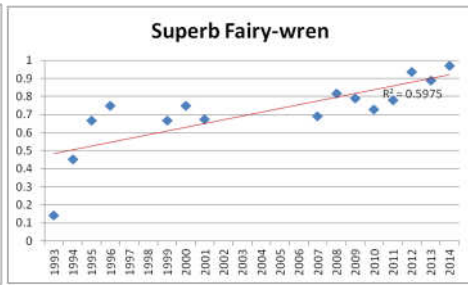
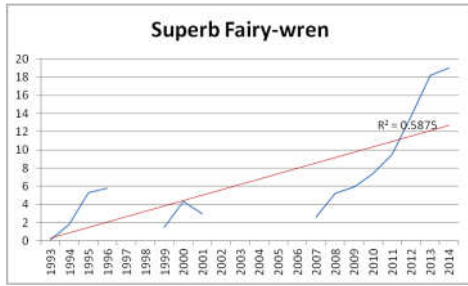
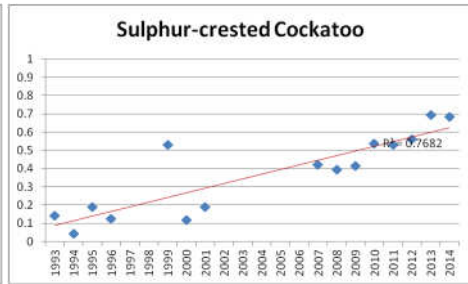
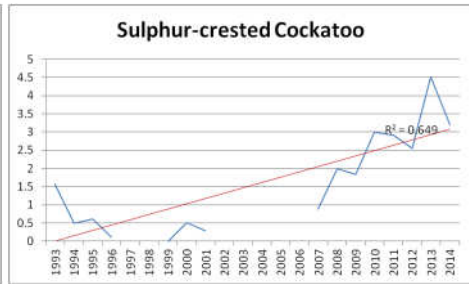
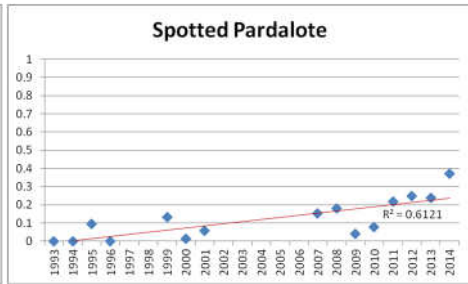
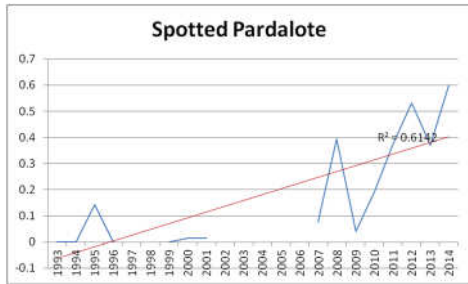
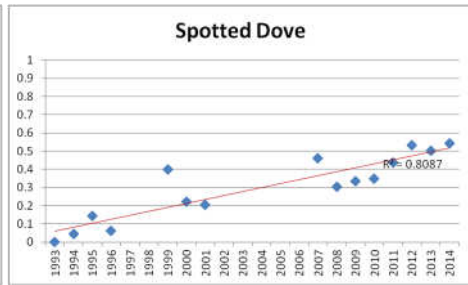
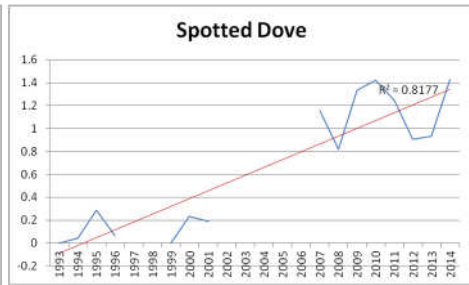
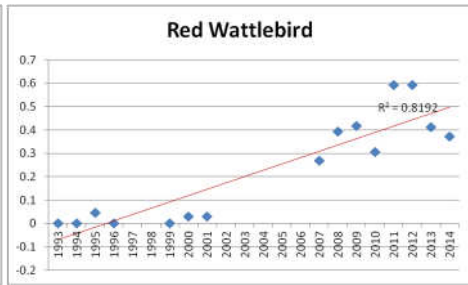
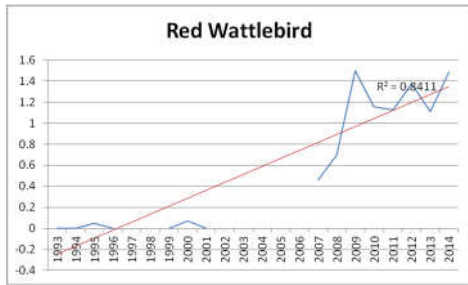
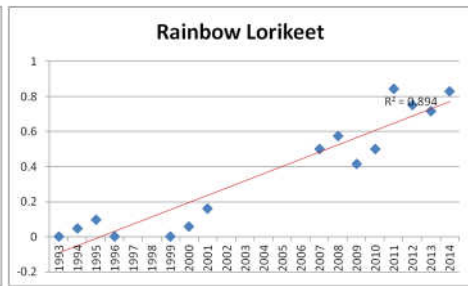
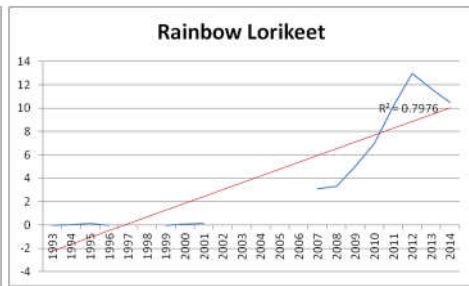
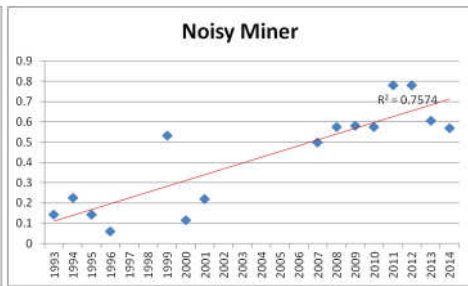
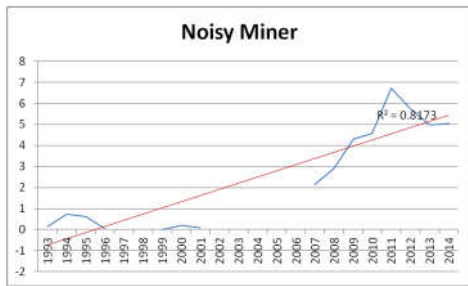
Appendix 5C Species Trends for Braeside Park. Figure on the left the standardised abundance data and the right being the reporting rate.

Increasing species

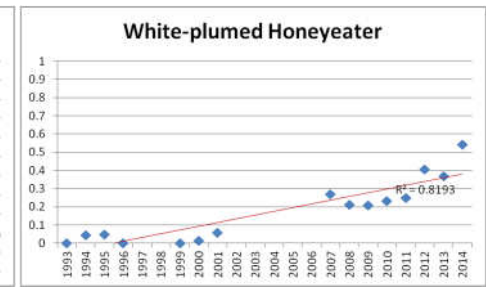
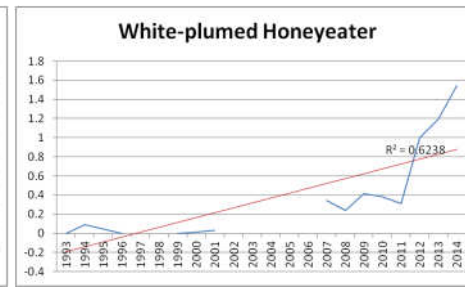
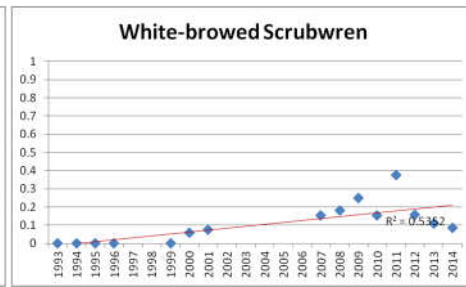
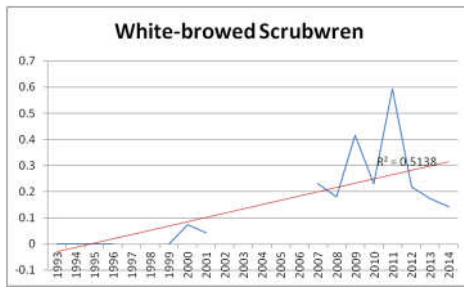




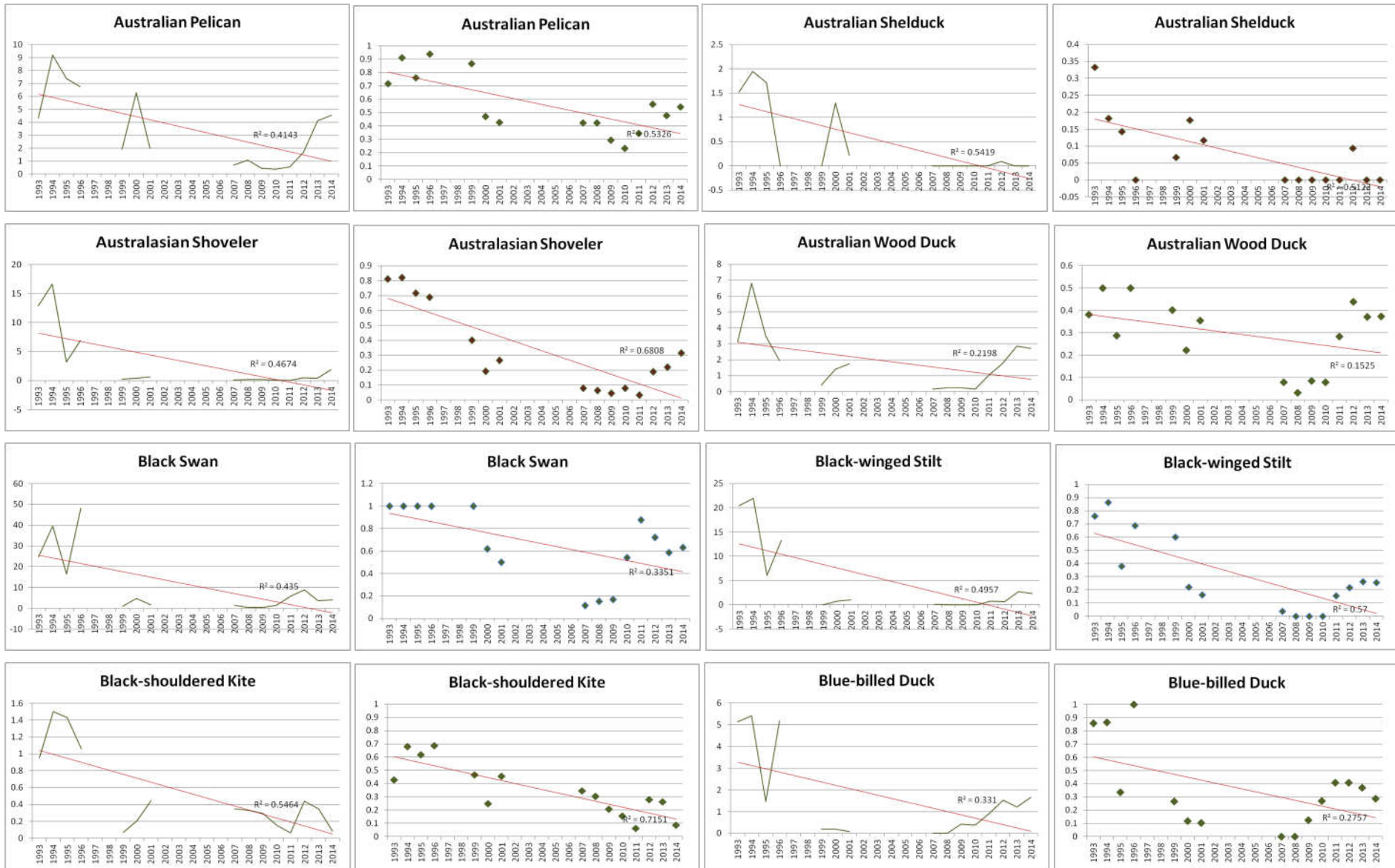


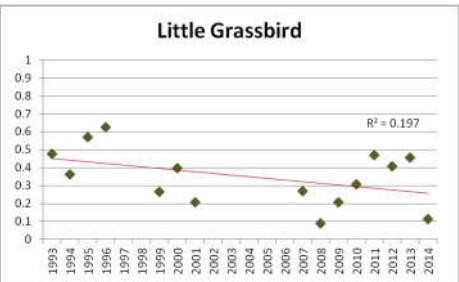
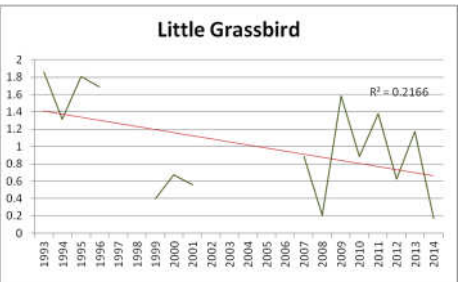
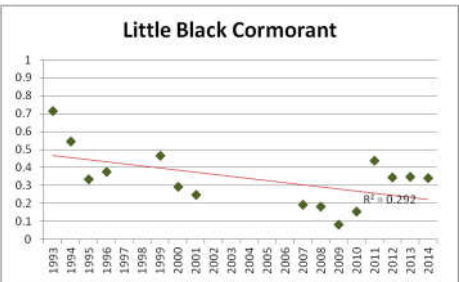
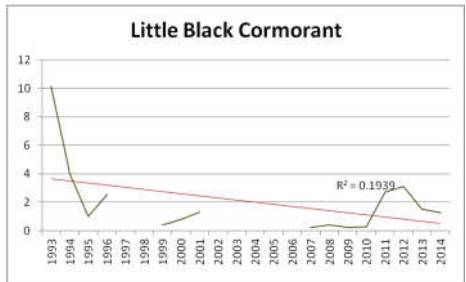
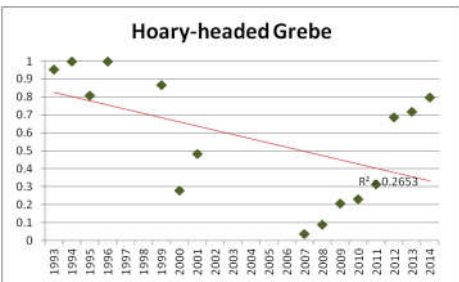
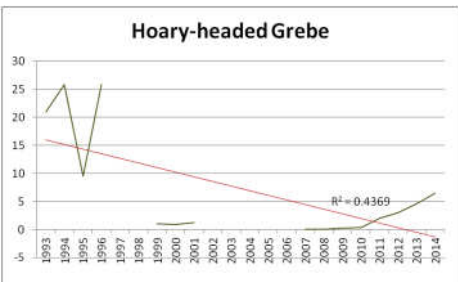
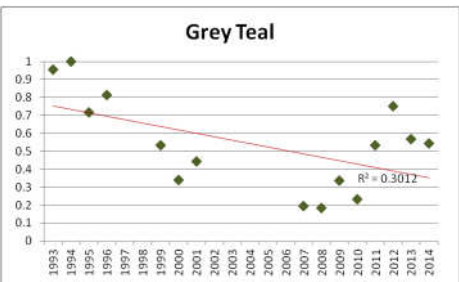
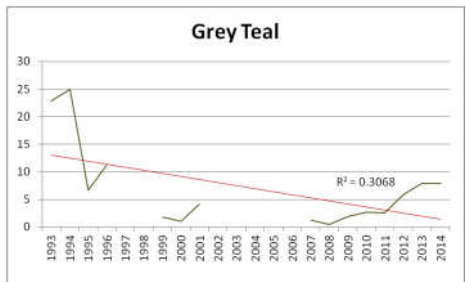
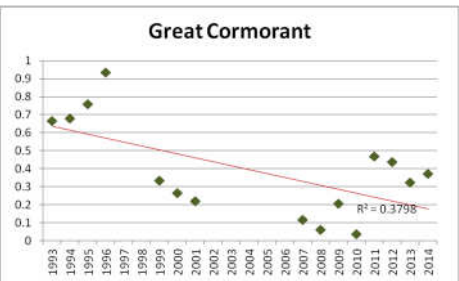
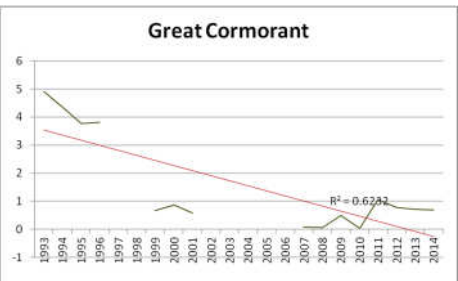
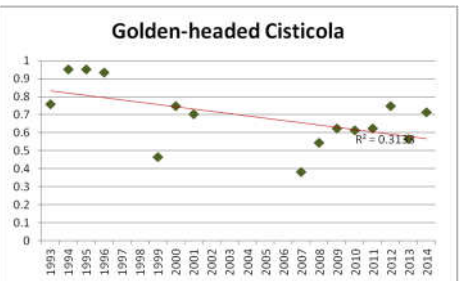
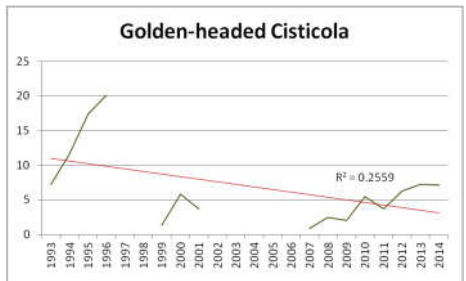
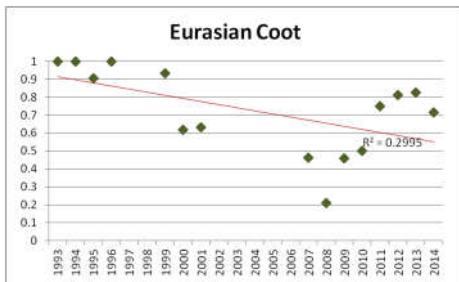
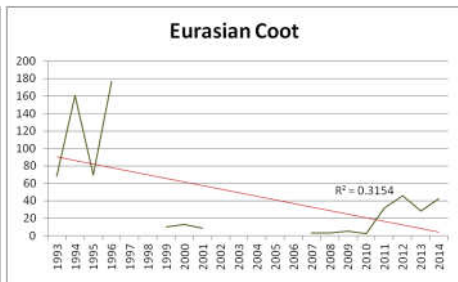
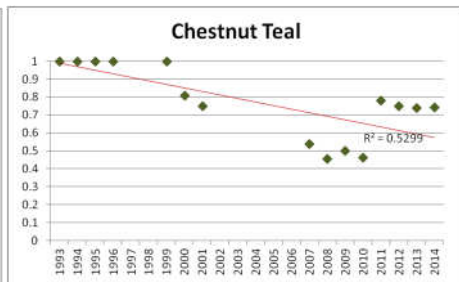
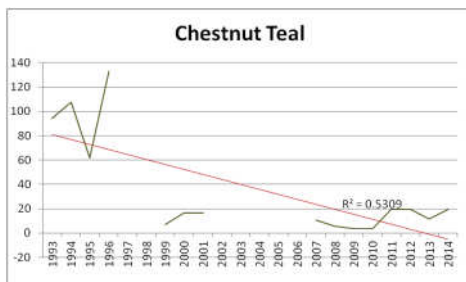


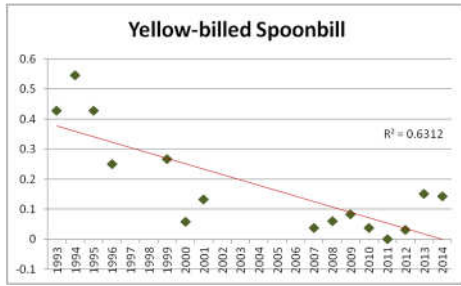
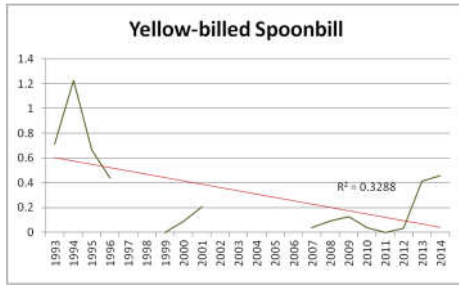
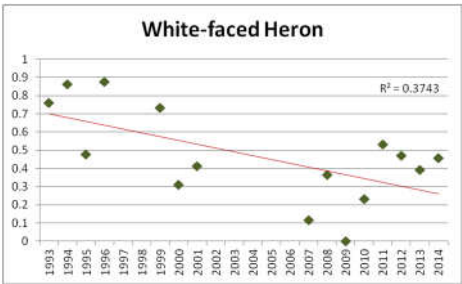
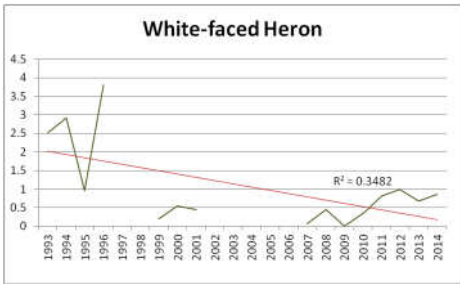
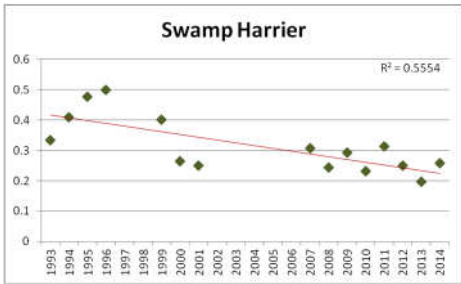
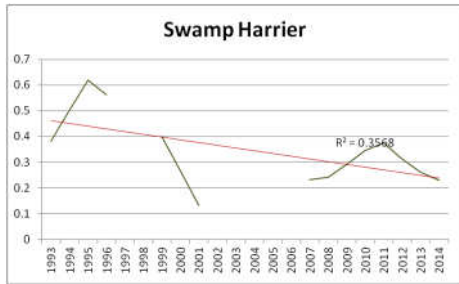
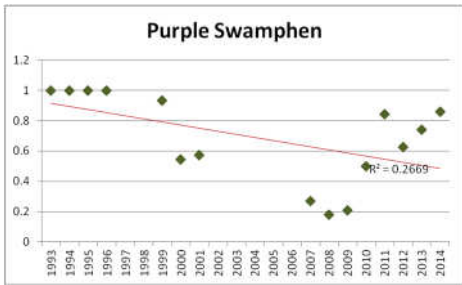
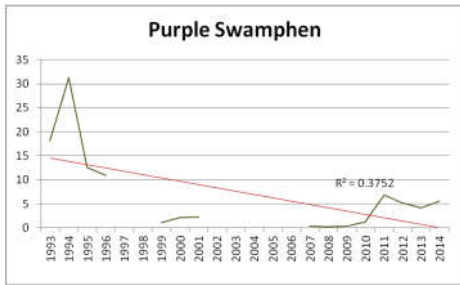
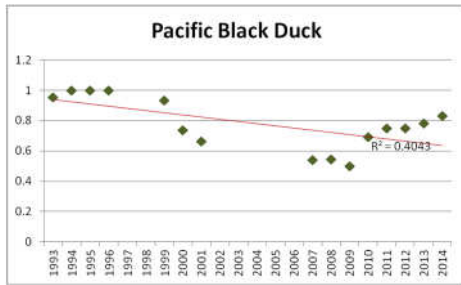
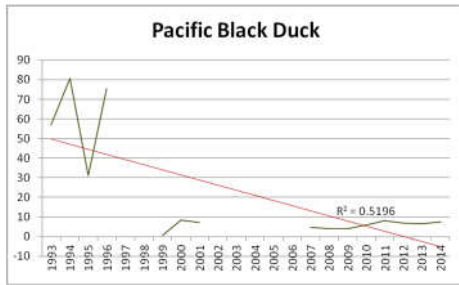
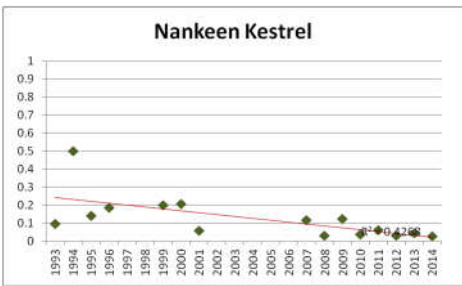
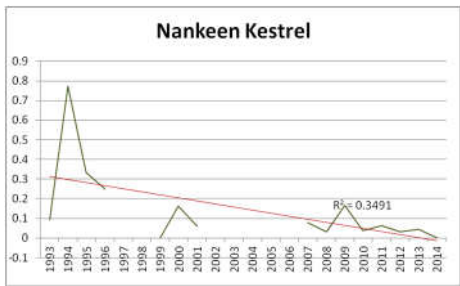
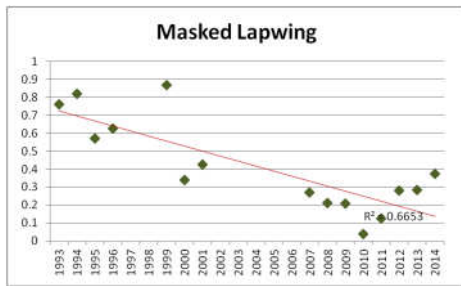
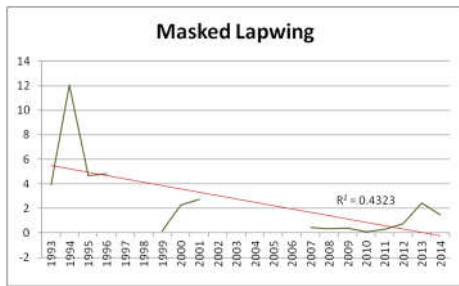




Declining species

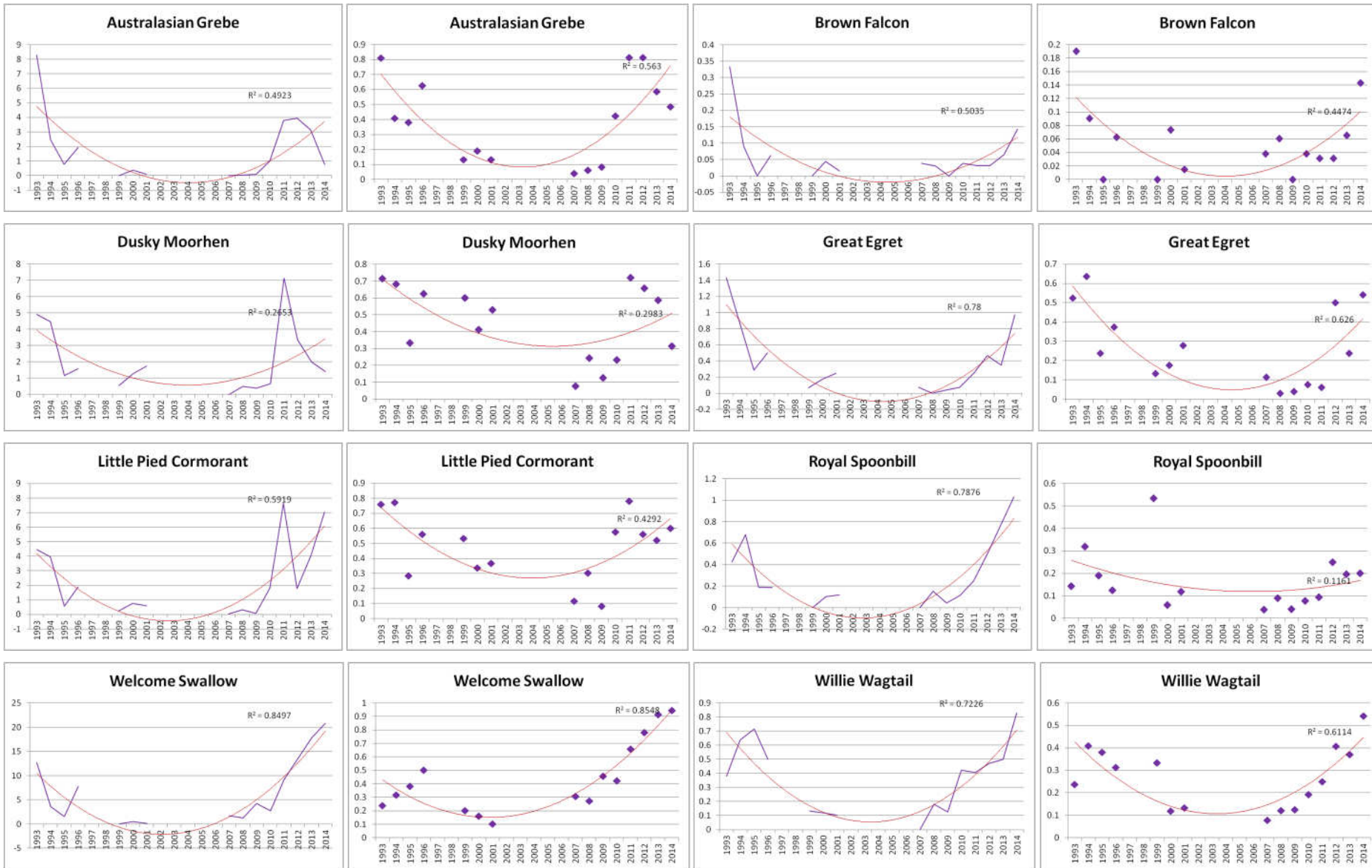






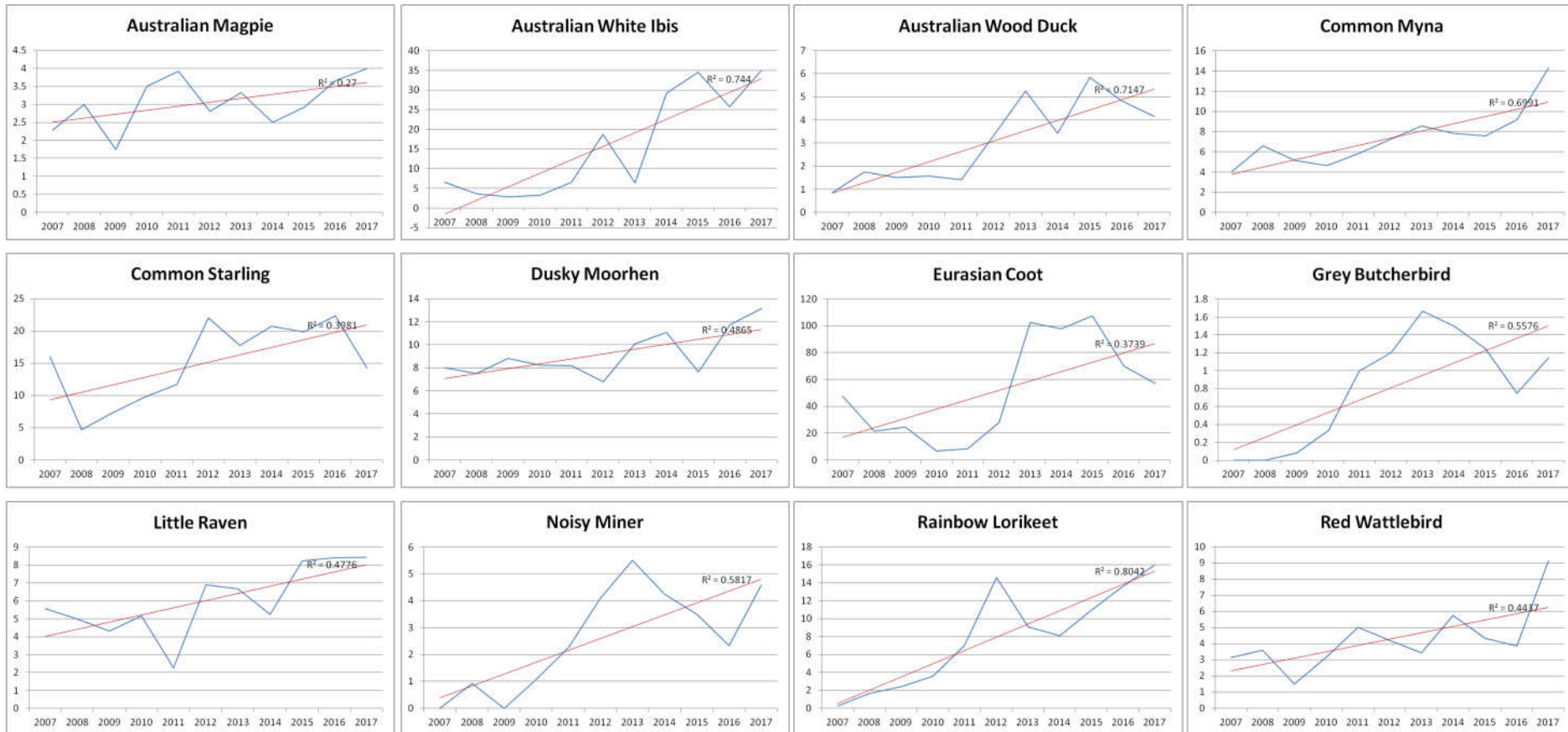


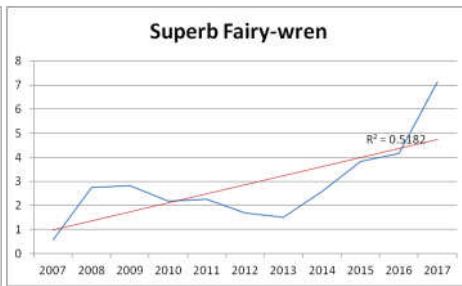
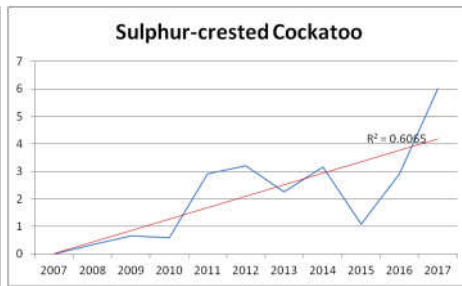
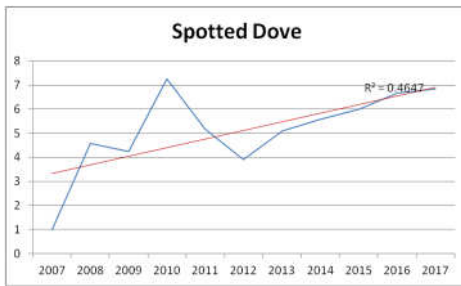
Variable species showing interesting trends



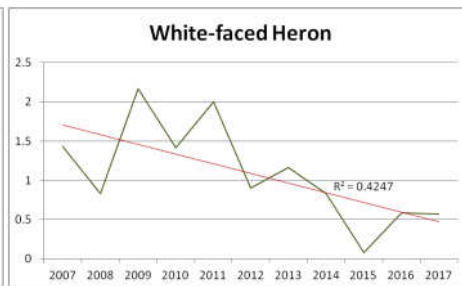
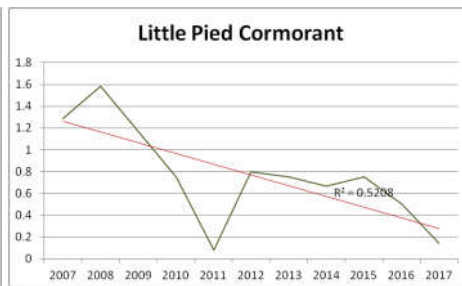
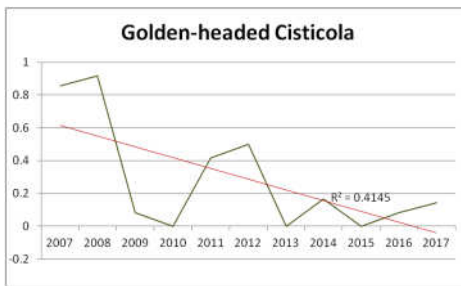
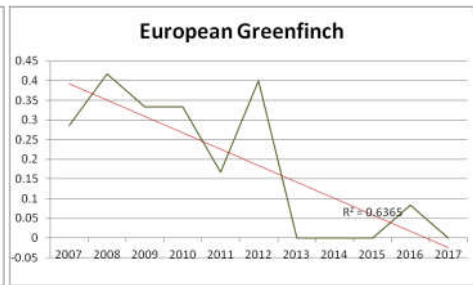
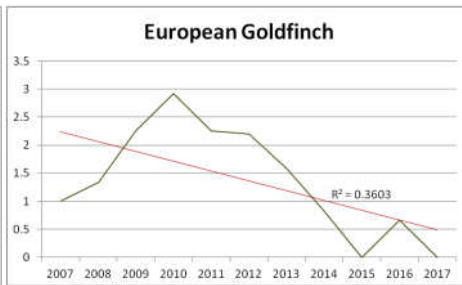
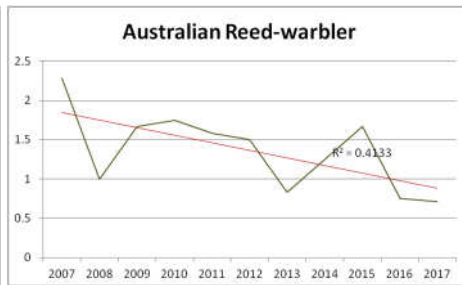
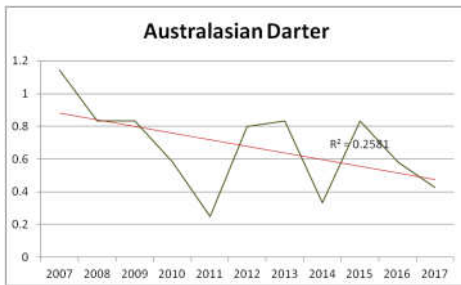
## Appendix 5D. Species Trends for constructed wetland Frog Hollow using standardised abundance data.

### Increasing Species

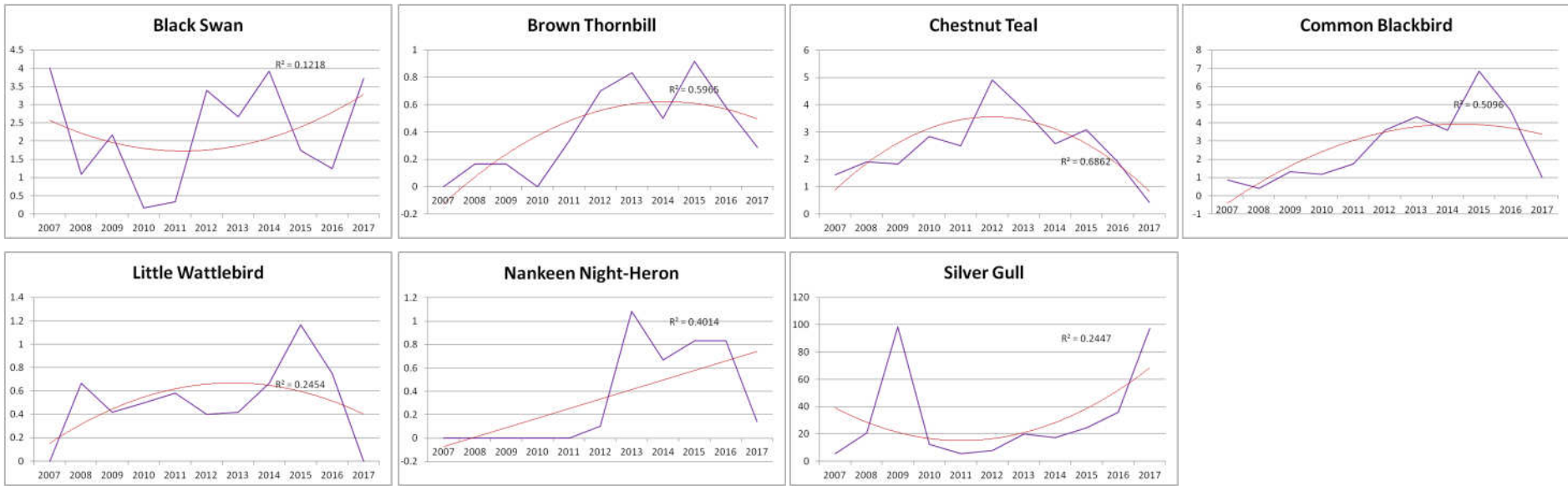




## Declining Species



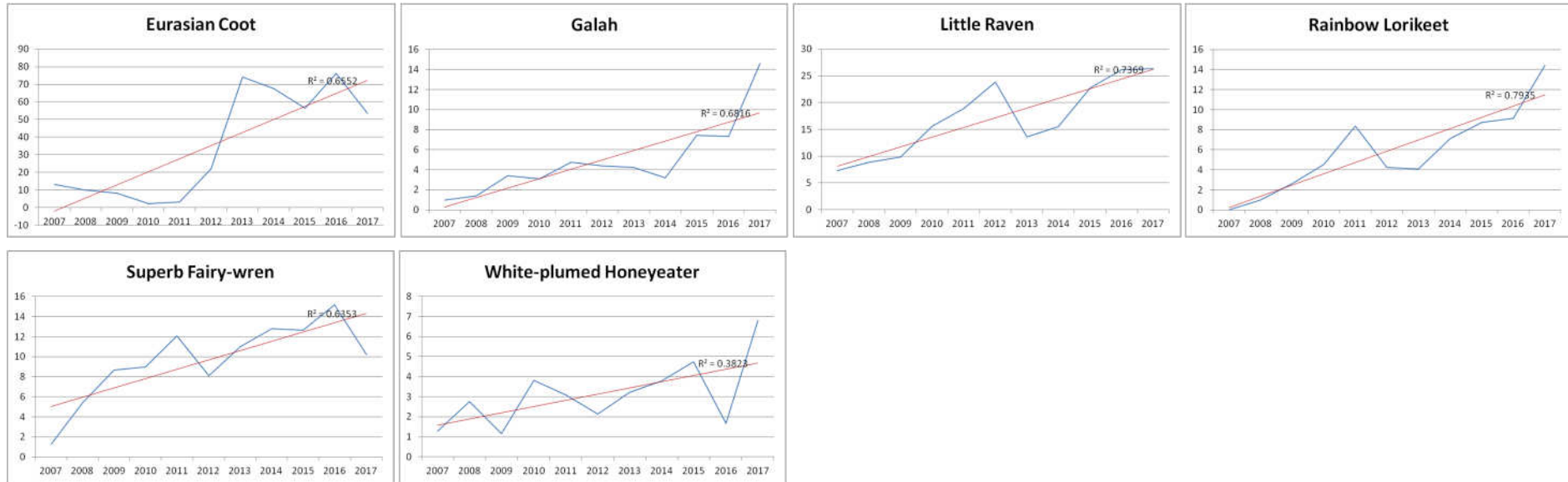
Interesting and variable species contributing to MDS plot



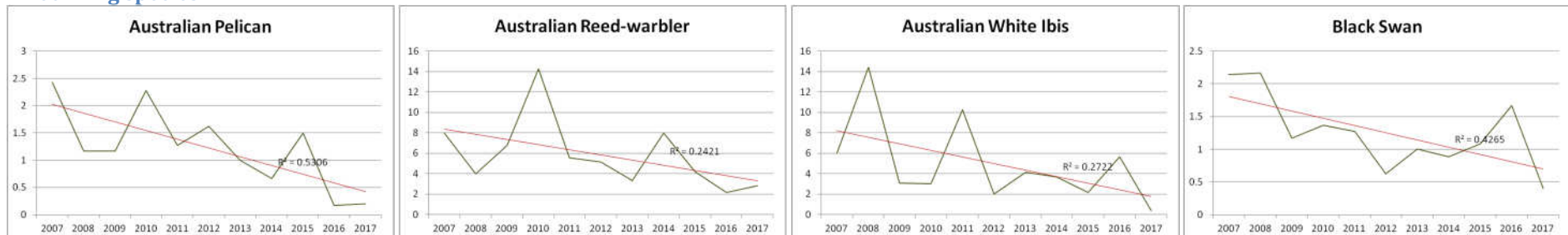


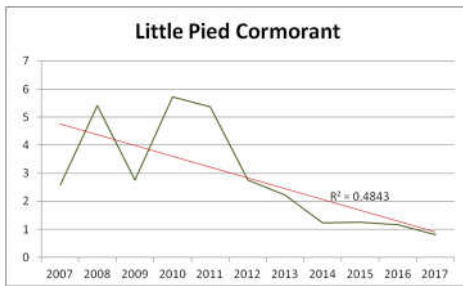
## Appendix 5D. Species Trends for constructed wetland Golf Links Road using standardised abundance data.

### Increasing species

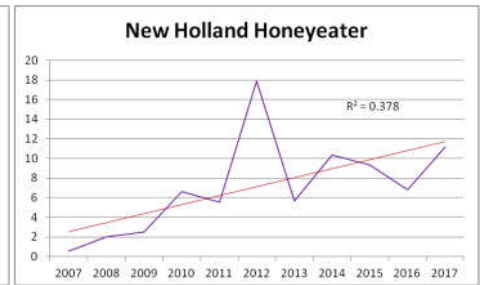
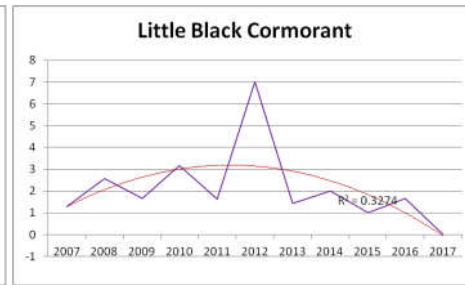
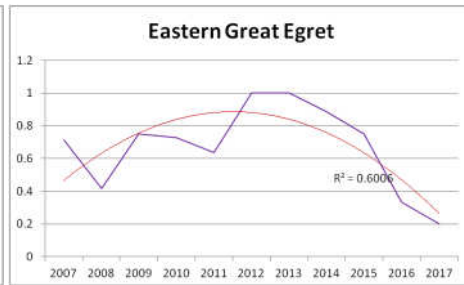
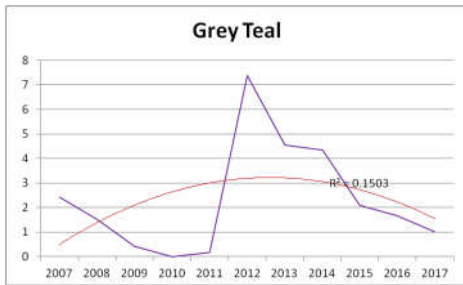
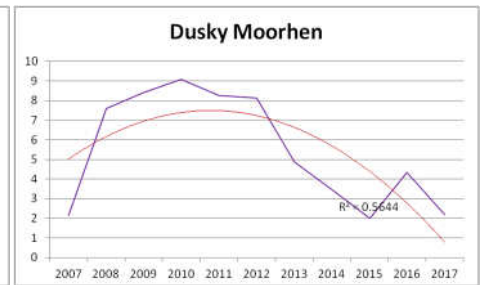
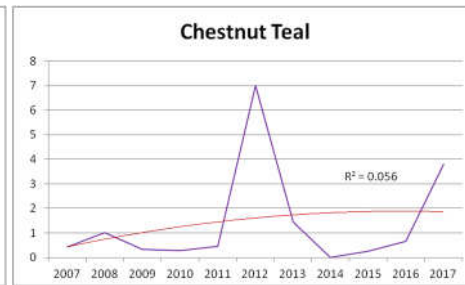
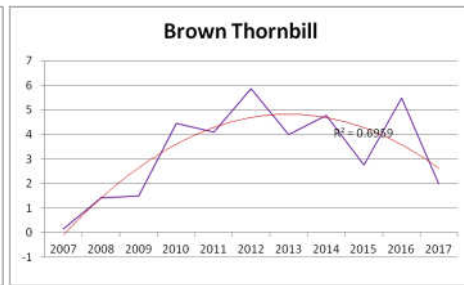
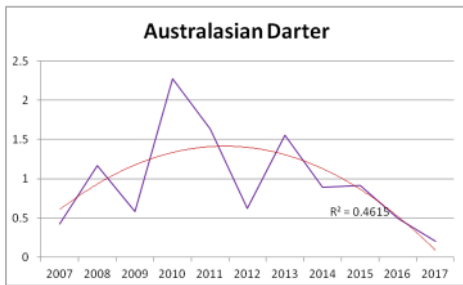


### Declining species



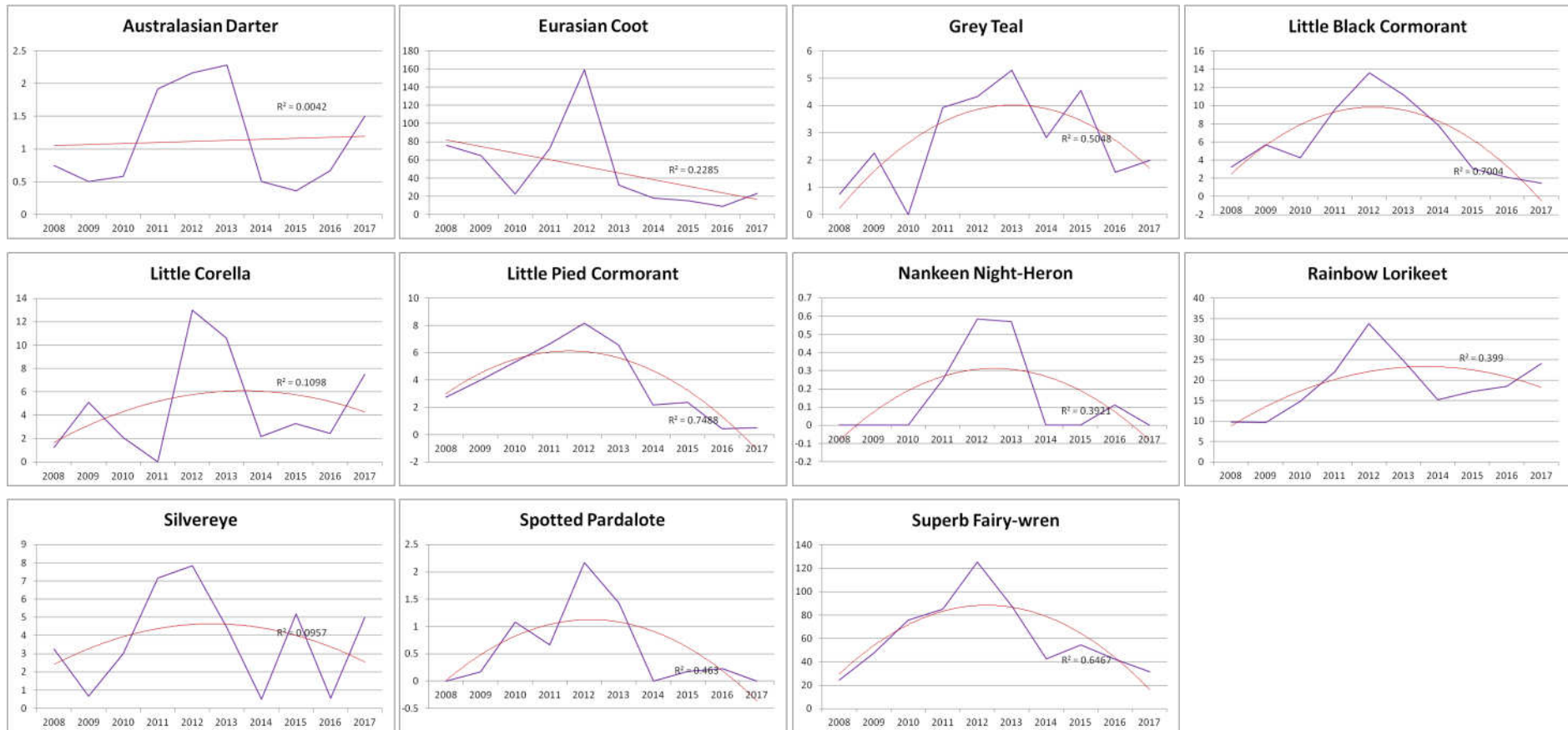


**Variable and interesting species contributing to MDS plot**

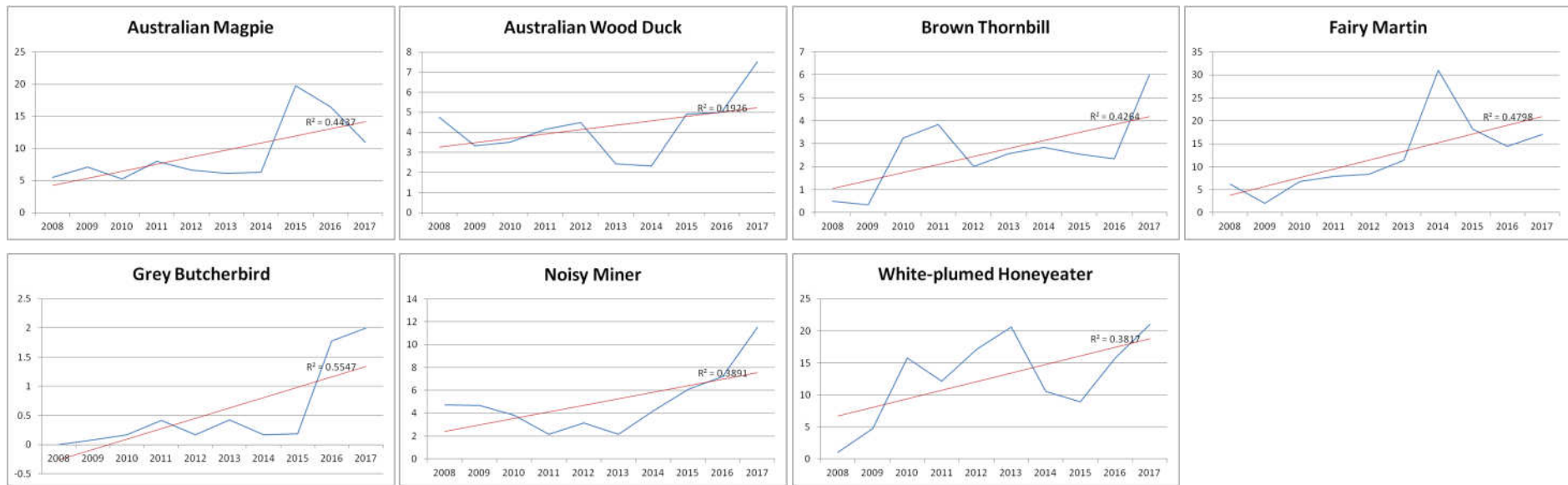


## Appendix 5F. Species Trends for constructed wetland Hallam valley Road Wetland using standardised abundance data.

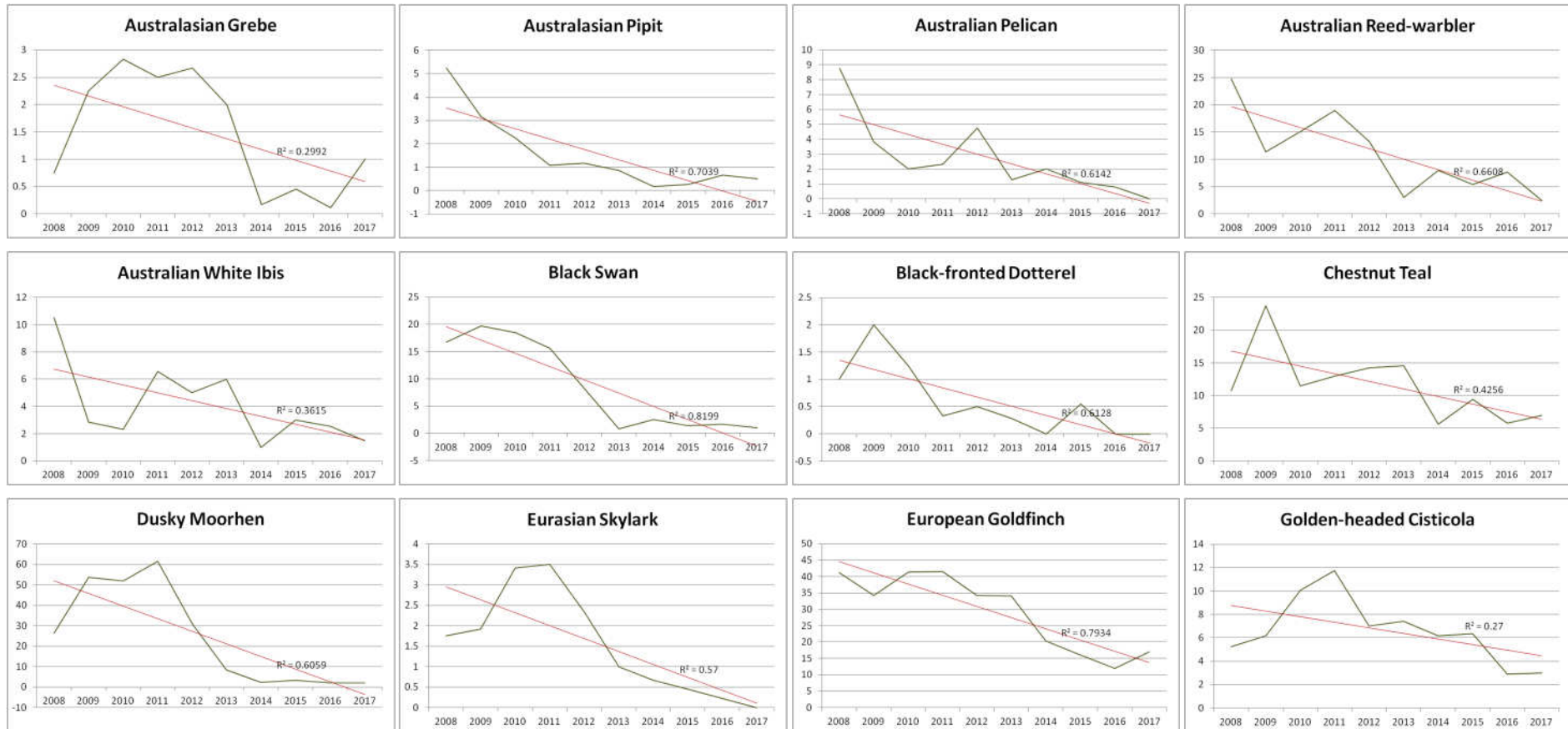
### Species contributing to MDS variation

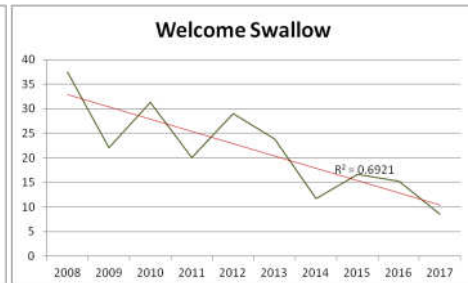
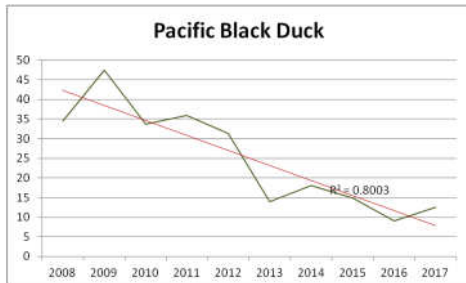
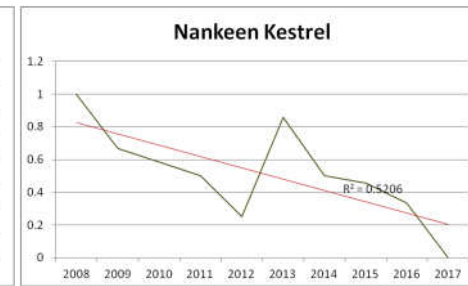
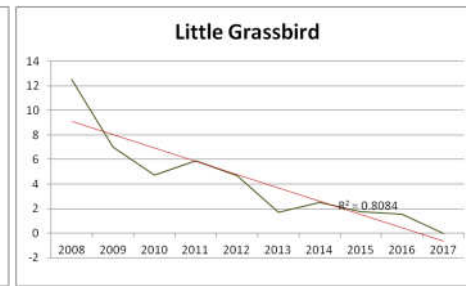
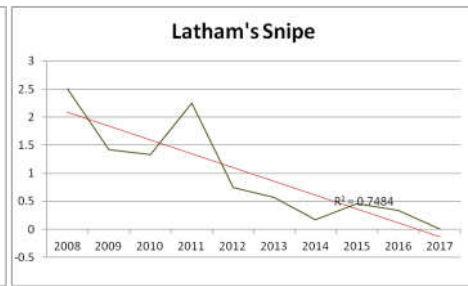
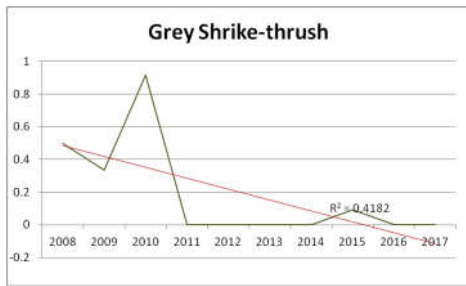


## Increasing species



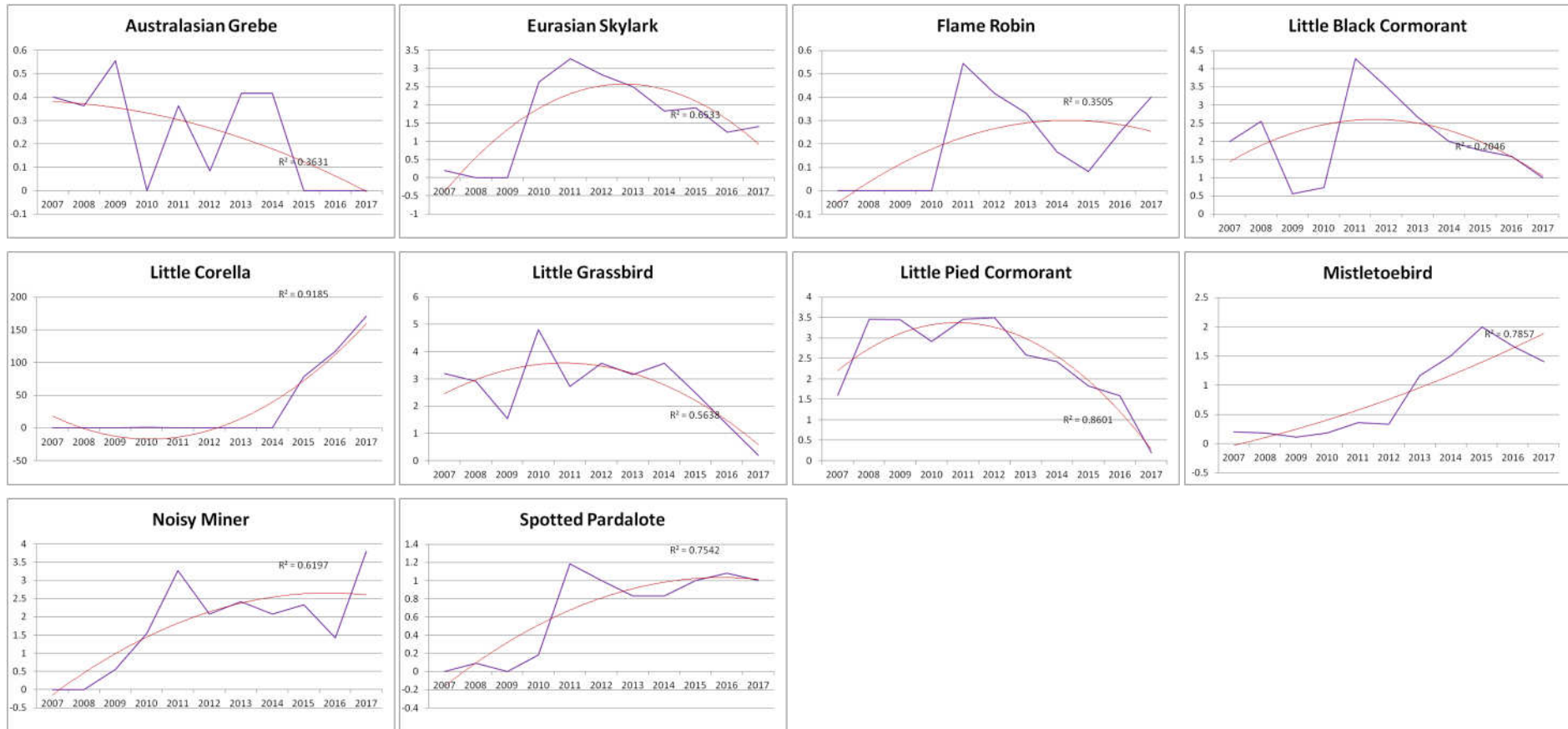
## Declining species





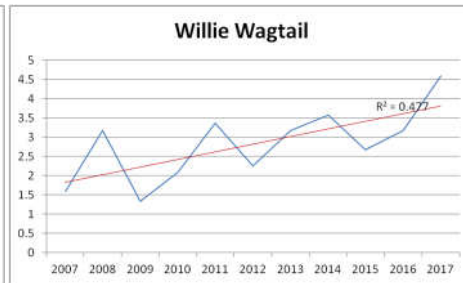
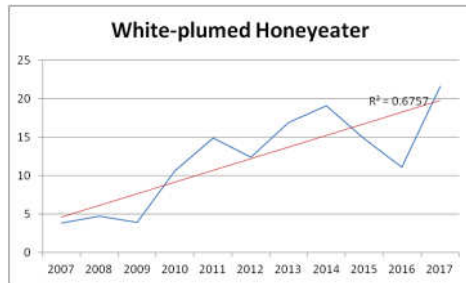
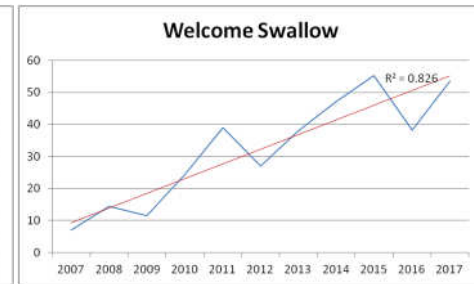
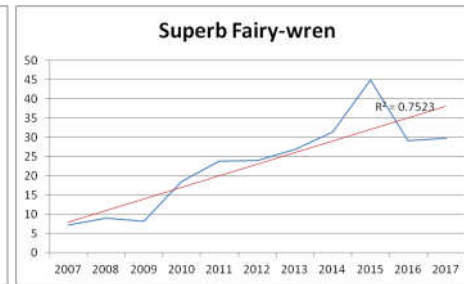
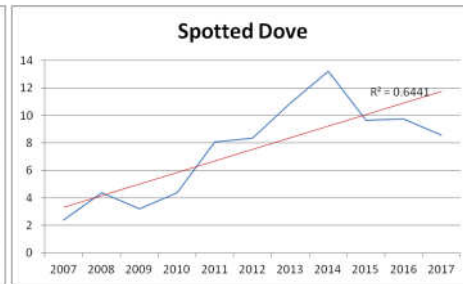
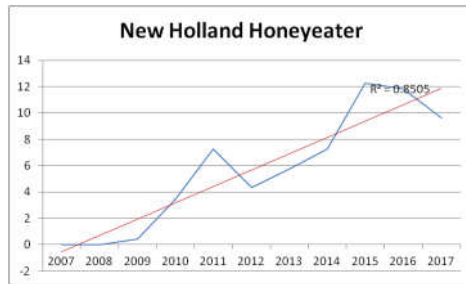
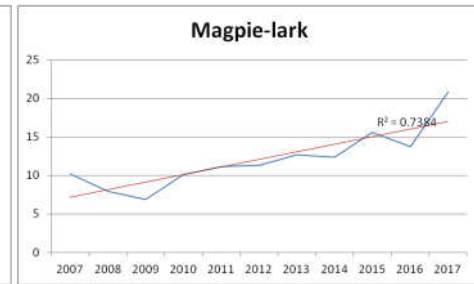
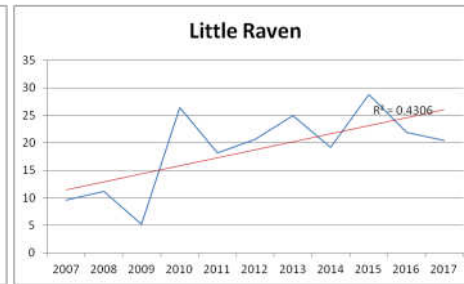
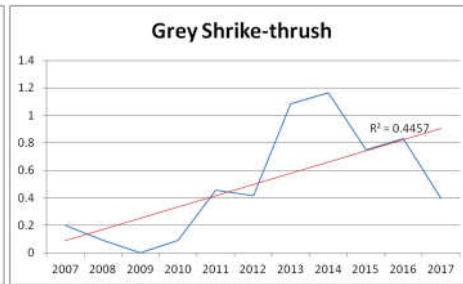
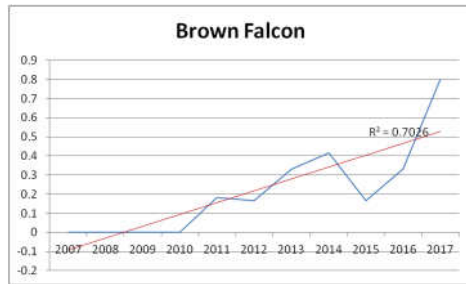
## Appendix 5G. Species Trends for constructed wetland Heatherton Road North using standardised abundance data.

### Species contributing to MDS plot



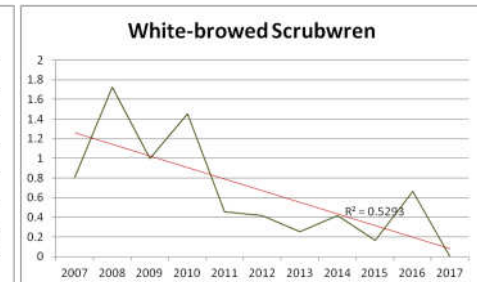
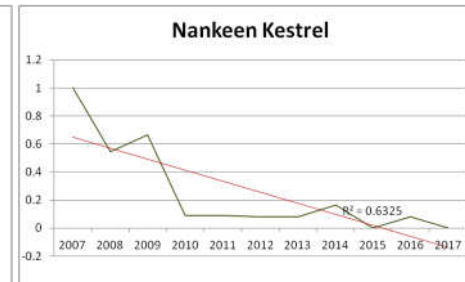
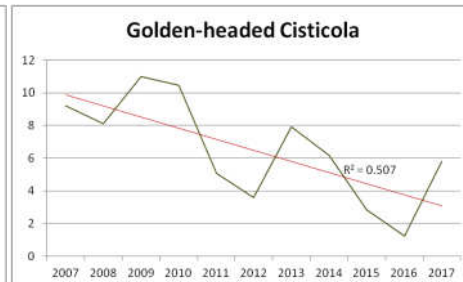
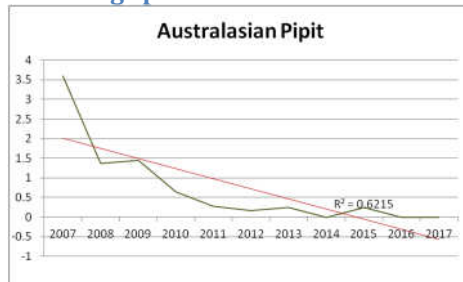


## Increasing species



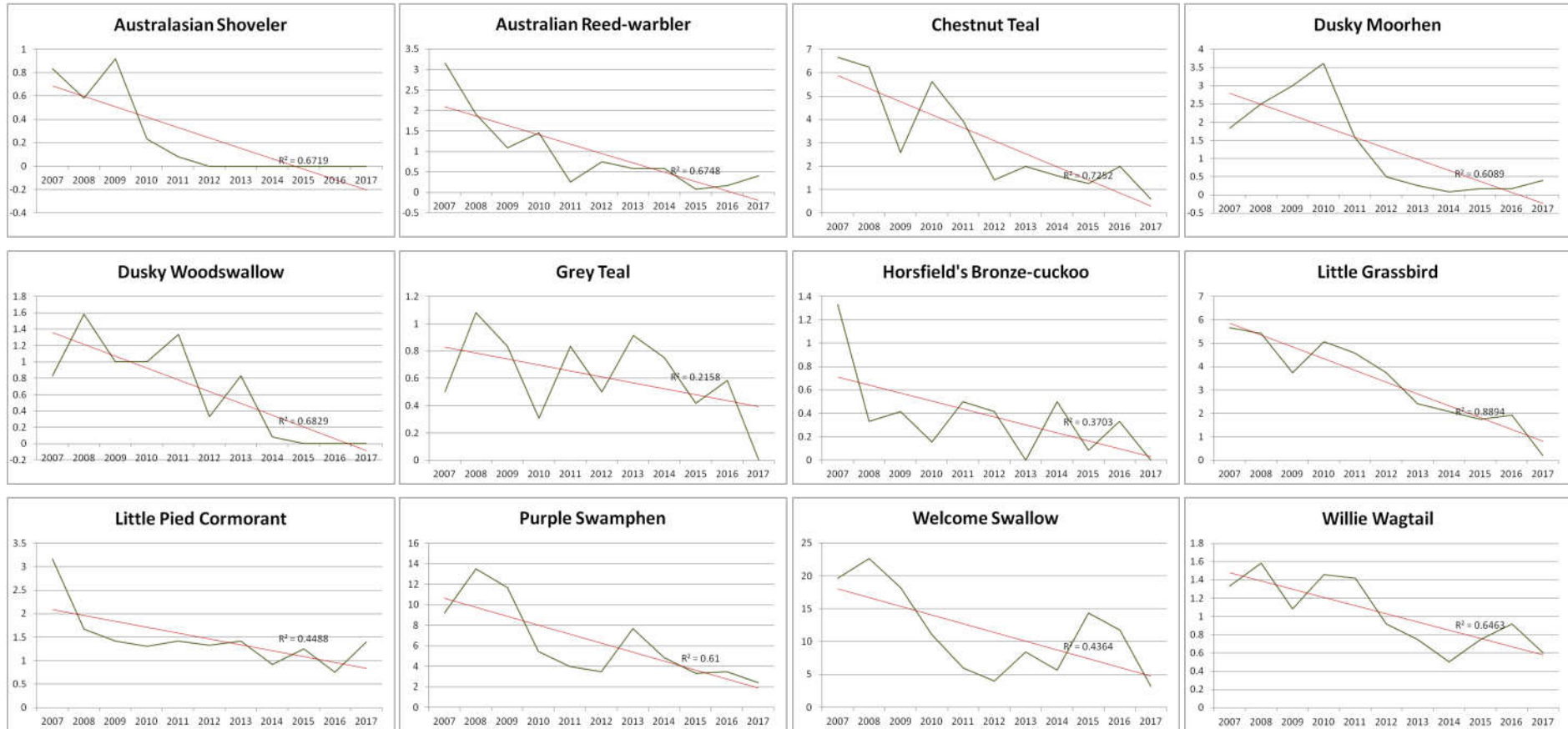


## Declining species

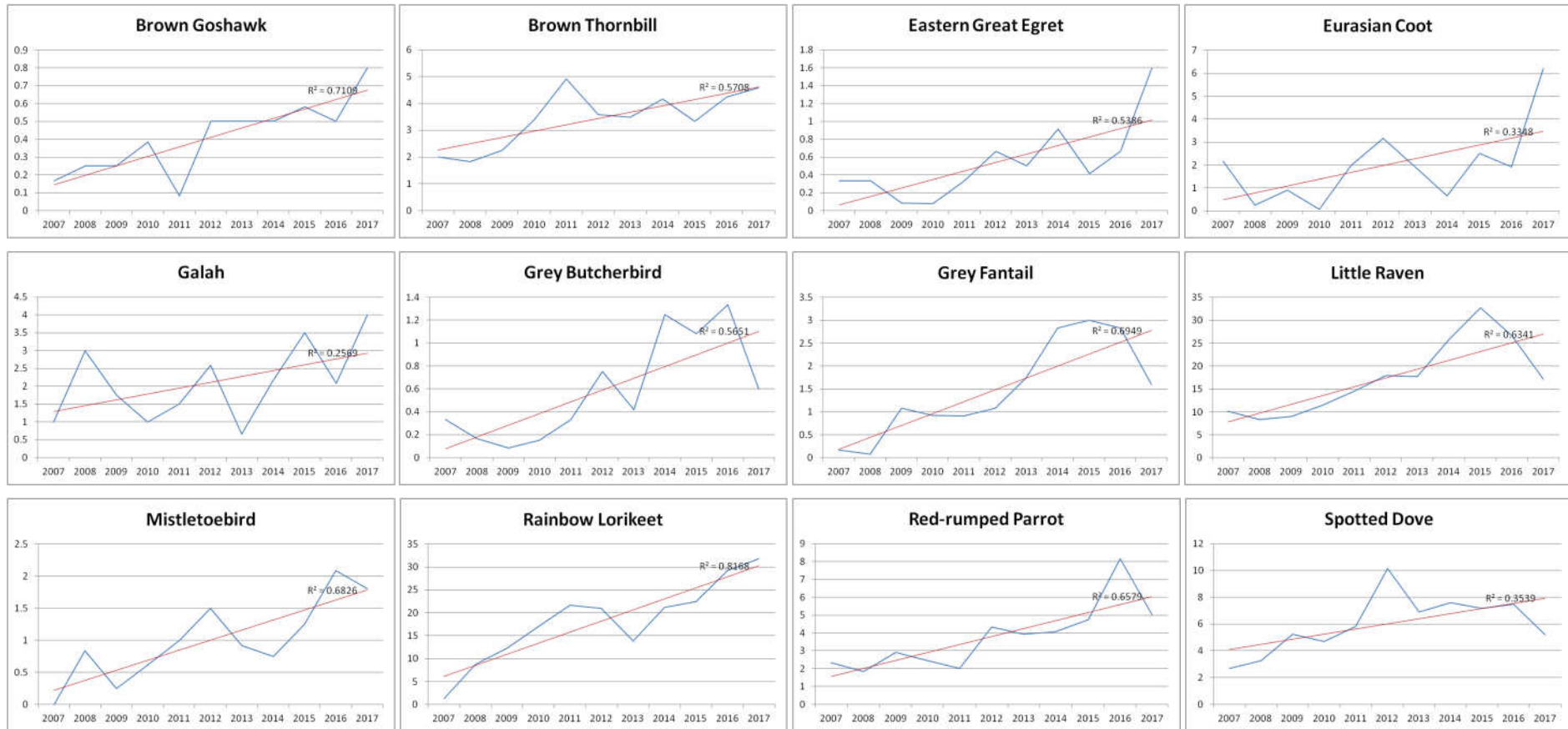


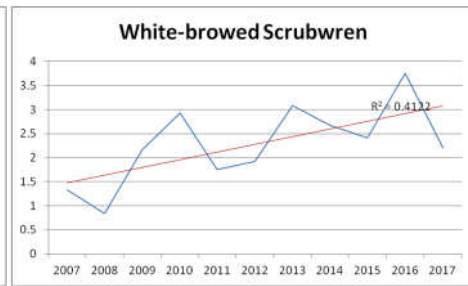
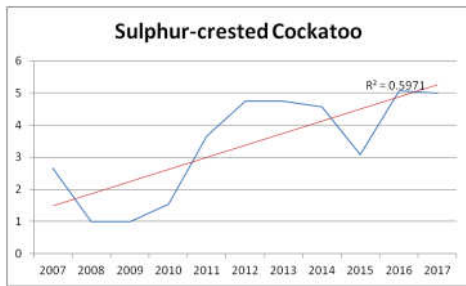
## Appendix 5H. Species Trends for constructed wetland Heatherton Road South using standardised abundance data.

### Decreasing species



## Increasing species





## Interesting or variable species

