Landbirds on Lord Howe Island, NSW
September 2019

Special report on a survey following rodent eradication project



Prepared for the Lord Howe Island Board
by the Canberra Ornithologists Group

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Summary

This report describes a survey of landbirds on Lord Howe Island conducted by the Canberra Ornithologists Group (COG) in September 2019. The survey was the sixth assessment of the status of landbirds on the island. Like previous surveys it was commissioned by the Lord Howe Island Board as part of a necessary monitoring processes associated with the project to eradicate rodents from the island.

Results from nine species were analyzed using generalized linear mixed models, allowing both fixed and random effects to be taken into account. An additional, two species had an insufficient number of observations.

Two of the eleven species from the plot surveys (Masked Lapwing and Song Thrush) could not be analysed due to the small number of observations. Four species showed a decline in 2019 when compared with previous years (Buff-banded Rail, Swamphen, Golden Whistler and Magpie-lark) whilst one (Silvereye) showed an increase. The remaining four species (Emerald Dove, Sacred Kingfisher, Welcome Swallow and Blackbird) did not show a change in abundance after rodent control.

None of the species analysed showed a statistical difference in abundance between the two groups of bait delivery methods used, that is, aerial baiting versus other baiting methods.

In general, where the habitat influences are included in the generalized linear mixed models they appear to be sensible and generally reflect what we know about the biology of the species. In comparison to previous reports, and with additional data, there is less potential difference between years than was noted for last year's report. Additional modelling may be necessary to clarify if this is a general result.

Of the five species analysed from the transect surveys only the Buff-banded Rail showed a decrease in 2019 compared with previous years. Of the remaining four species (Emerald Dove, Sacred Kingfisher, Song Thrush and Blackbird) none showed a decrease in abundance after rodent control.

The timing of the survey in relation to baiting during the rodent eradication project and changes in habitat and food resources caused by the removal of some livestock may have affected non-target species in ways that cannot be measured unless surveys are repeated in 2020 and possibly 2021.

Introduction

This report describes a survey in September 2019 of landbirds on Lord Howe Island (latitude 31° 33´S and longitude 159° 05´E). The survey was the sixth annual assessments of the status of landbirds on the island and was conducted following completion of the main field work of a rodent eradication project that started in June 2019. Previous surveys, conducted in 2013, 2014, 2016, 2017 and 2018 have been reported (Fullagar *et al*., 2014, Fullagar *et al*., 2015, Fullagar *et al*., 2017, Fullagar *et al*., 2018, Fullagar *et al*. 2019). These surveys were commissioned by the Lord Howe Island Board as part of the necessary monitoring processes associated with efforts to eradicate rats and mice from the island.

The purpose of past surveys has been to provide baseline information on the numbers and distribution of landbirds on Lord Howe Island. In this report we provide information on the short-term effects of the rodent eradication baiting project. Landbirds are here defined as those species that are either breeding residents on the island or land-based visitors. Specifically, all seabirds are excluded but shorebirds are not.

The bird surveys were started on 10 September, that is just under 9 weeks after the aerial baiting commenced with some hand baiting still occurring during the bird survey period (see more details below). As for all of our past surveys a rigorous method has been used to provide data that can give a statistically sound measure of significant changes in population numbers and distribution – if they occur.

We investigated the power of available statistical analyses achievable with a point count method of population assessment (Nicholls, unpublished) and adopted the data collecting protocol we believe best fitted the limitations of time and effort available in the field. As an additional dataset we did, however, use a simple transect procedure to assess the abundance of species within the most closely settled area of the island. These transects were walked at dusk (and for a small sample at dawn) using the network of sealed roadways.

For a review of the historical records of birds on Lord Howe Island see Fullagar *et al.*, 2014. The analysis of this report is different to the five previous reports. In Fullagar *et al*., 2014, Fullagar *et al*., 2015, Fullagar *et al*., 2017, Fullagar *et al*., 2018 and Fullagar *et al*. 2019 we asked whether, for any one species, there was a statistical difference in abundance between years. For this report we ask whether, for any one species the post eradication survey (conducted in 2019) was statistically different from that observed in previous years. This required a different statistical model being fitted from those reported on in previous reports and cannot be compared with models reported in previous years.

Rodent Eradication Project

Investigation into the feasibility of a project to remove rodents (Roof Rat *Rattus rattus* and House Mouse *Mus musculus*) from the island began in 2001; the first draft plan was drawn

up in 2009, and funding achieved in 2012. Following extensive environmental and human health assessments of this proposal, the Lord Howe Island Board voted to proceed with the project in 2017. Finally, in 2019 the project was implemented.

The methods used were those that had evolved over nearly 40 years of island rodent eradication projects around the world. The experience and the science from these earlier projects was incorporated into the Lord Howe island Rodent Eradication Plan, with review by international experts in this field.

The methodology was to expose every rat and mouse on the island to a cereal bait containing the active ingredient '*brodifacoum*', an anticoagulant. The bait used was '*Pestoff*' 20R, a cereal pellet incorporating the active ingredient *brodifacoum*.

To achieve this on an inhabited island, four methods were used to deliver the baits.

- Away from the settlement helicopters were used to distribute bait pellets very accurately to the ground, at an application rate of 12 kg per hectare.

- In the settlement area with dwellings, paddocks and native vegetation, a network of bait stations was used with a bait station on the ground every ten metres. This equated to approximately 19,800 bait stations.

- In all buildings, smaller bait stations were used to expose all mice to a bait, with each room having a bait station. Roof cavities were also baited and for those roof cavities without internal manhole access, baits were installed by lifting roof sheeting.

- In between the areas treated with bait stations and in the mountains, areas of pastures were treated by workers hand broadcasting bait pellets, at ten metre intervals, in the first week of June.

In April the empty bait stations were deployed across the settlement using differential GPS (Global Positioning System) for high accuracy and placement under the forest canopy.

To ensure no endemic species were harmed by *brodifacoum*, the project included the capture and captive management of Woodhen and Pied Currawong. During April and May 2019 staff from Lord Howe Island Board and the NSW Department of Planning, Industry and Environment caught 225 Woodhens and 122 Pied Currawongs and brought them to specially designed aviaries constructed on the island. This work was completed by 24 May. Staff from Taronga Park Zoo were on the island from April through to November to care for these captive birds.

With the removal of Woodhen and Pied Currawong into captivity no analysis has been conducted on these two species.

Bait stations were prepared and hand broadcasting of baits was carried out from 21 May, after the Woodhens and Pied Currawongs had been successfully housed in their aviaries. In June, two helicopters arrived on the island, in preparation for aerial distribution of pellets. The first of these applications began on 6 June, and the second application was in the first week of July. Final aerial and hand broadcast baiting was completed by 12 July.

Hand baiting was continued each week in the settlement area by topping up the bait stations using the same *Pestoff* 20R pellets. All baiting stations were checked and replenished every 7 to 10 days. Additional hand broadcasting (where bait stations were still having active bait take or rodent activity had been reported) was completed by 23 August. Final baiting in ground bait stations was completed by 1 November.

Removal of introduced Masked Owls was a part of the project, and it was deemed essential to remove all of these birds that were introduced in the 1920's to eat the rats. With the rodents gone, the owls would switch to eating seabirds and Woodhens. It was believed 40 to 50 Masked Owls were living on the island, and 14 were found dead from secondary poisoning. A team of professional shooters, and locally trained shooters was engaged to eradicate them totally.

A Technical Advisory Group had been set up to provide technical advice to the Lord Howe Island Rodent Eradication Steering Committee and be responsible for providing advice and recommendations for the development and implementation of the Monitoring and Mitigation Plan to minimise the impacts from aerial baiting on non-target species and the environment in relation to the Lord Howe Island Rodent Eradication Project.

The committee met weekly to review weekly reports regarding non-target species mortality and efficacy of carcass searches and removal for a period of 4 months after the baiting started.

Non-target species searches were conducted in accordance with the Environment Protection and Biodiversity Conservation (EPBC) Mitigation and Monitoring Plan and the Australian Pesticides and Veterinary Medicines Authority (APVMA). Risk Mitigation Plan. Permit listed species refer to those listed in the EPBC Mitigation and Monitoring Plan (Golden Whistler, Silvereye and Pied Currawong) and additional species listed in the APVMA Risk Management Plan (Buff-banded Rail, Swamphen, Australian Kestrel, Sacred Kingfisher, and Pacific Black Duck).

The 2019 landbirds survey was conducted between 10-16 September, that is 60 days after

the aerial baiting although some strategic hand baiting was still occurring during the landbirds survey period.

Breakdown of the *Pestoff* pellets was monitored, and when no whole baits remained on the ground and the killed rodents had decomposed, the release of captive Pied Currawong began. Captive Pied Currawongs were released in a staged process. Five pairs fitted with radio transmitters on their tails were released in the first week of September and after a period of two weeks with all of those birds surviving it was assumed the environment was safe to release the remaining birds.

Ten 'sentinel' Woodhen were released at the Waste Management Facility. Due to small (2ppm) levels of Brodifacoum in the blood of these birds sampled after two weeks in the wild, a release of further sentinel Woodhens will be carried out and blood samples of these and the original sentinel birds monitored for no residual Brodifacoum before the bulk of the Woodhens are released.

Ground baits stations were removed in November 2019. The project of monitoring for any residual rodents using detection devices and sniffer dogs continued to mid-December.

Monitoring will continue with detection devices and dogs. In two years' time an island wide search effort with specially trained sniffer dogs will determine if the projects has been successful.

Methods

For a description of terms, choice of plots, plot count protocol and transect survey protocol see previous reports, (Fullagar *et al*., 2014, Fullagar *et al*., 2015, Fullagar *et al*., 2017, Fullagar *et al*., 2018, Fullagar *et al*. 2019)

Statistical model of plot counts

As the primary objective of the analysis reported here is to assess the impact of rodent control on the abundance of a suite of common species a generalized linear mixed model (GLMM) was the starting point for the analysis of the combined (2013, 2014, 2016, 2017, 2018 and 2019) data. We have accounted for the non-normal distribution of the counts and the structural components of the survey design. We assume that the counts are drawn from Poisson distributions. The fixed effects fitted to the 'null' model are vegetation group, (a three-level factor) derived from the vegetation type and zone to account for potential spatial effects. The random effects included site, observer and day as for the GLMM fitted in previous years.

All models were fitted using the R software (R Core Team, 2015) and the package 'lme4' (Bates *et al.*, 2014). The effect of rodent control is tested by comparing the 2019 counts

with all the previous years as a two-level categorical factor. As various bait delivery techniques were employed, aerial baiting North and South Hill and various combinations of hand baiting and bait stations, we grouped the baiting techniques into two category groups; aerial baiting versus the rest and have tested to see if the delivery technique had a significant inpact on the observed abundances if the initial test of difference between 2019 versus the previous years were significant. Model comparison was assessed using a log likelihood ratio statistical test and the AIC Information statistic to rank the suite of fitted models (Burnham and Anderson, 2002).

As in the past, due to the difficulty in collecting reliable abundance data for Silvereye, only presence or absence data are available. Appropriate models fitted to these data assume a binomial error structure and a logit link function.

Statistical analysis of transect data

There are two groups of potential predictors of the abundance of the observed species. The first group characterizes the observations in terms of physical characteristics of the transect (length), the direction of the traverse (out or in) and the duration of the count (duration) or the average speed of travel (speed). These physical characteristics are all connected. More individuals would be expected to be observed on longer transects, or during longer travel times or slower speeds of travel; there is no a priori reason to think that direction of travel should influence the number of individuals observed. Note however, previous results have implicated direction of travel as being strongly associated with abundance of some species. The primary question being asked of the 2019 observations is there an effect on the observed abundance relative to that observed in previous years that could be attributed to the rodent control baiting project?

To facilitate this a null model was fitted that included the random effects, transect, Observer and Day and the fixed effect Direction of travel. This model was then compared with an enhanced model that included rodent control (a two-level factor). Models were compared using a log likelihood ratio statistic and model weighting using the AIC theoretic approach.

Species names

Species names used in this report follow current preferred internationally accepted nomenclature (see Appendix). For simplicity, some of the common names have been shortened to conform with island usage.

Survey dates and weather conditions

The flight from Canberra to Sydney was cancelled for 24 hours due to high winds in Sydney. The start of the survey was delayed for one day but a spare morning on the 16 September before the afternoon departure flight allowed both the point count and the transect surveys to be completed.

The 2019 plot counts were surveyed between 11 and 16 September with the transect surveys conducted between 10 and 15 September, and the final morning transect survey conducted on 16 September. For the point count surveys, teams were in the field soon after dawn each day and ready to start by about 06:00. Teams often worked through until late morning. The time to complete a set of counts varied mostly due to the time taken to reach all allotted count plots. The evening transect surveys, however, started at 17:00 each day with the morning surveys starting at 6:30.
The weather for the point counts was generally cool with slight winds clearing to sunny conditions on most days. On the morning of the 13th there was a frontal passage which brought showers resulting in one of the 384 plots not being surveyed.

For the evening transect counts the weather was generally fine but with breezy to strong winds at times on all days. The passage of fronts on the 10 September and again on the 14 September produced windy conditions on all transects. Some weather observations for the week are shown in Table 1.

Table 1. Selected daily weather observations, LHI, 10–16 September 2019

Date	*Day*	*Min °C*	*Max °C*	*Rain (mm)*	*Wind Direction*	*Max. wind speed (km/h)*
10	Tue	12.8	18.4	2.4	SSW	57
11	Wed	13.9	19.2	1.2	SW	54
12	Thu	12.1	19.6	0.0	WNW	22
13	Fri	14.2	19.9	0.0	W	48
14	Sat	14.9	19.3	3.8	WSW	39
15	Sun	16.0	18.9	0.2	SW	43
16	Mon	11.0	20.8	0	WNW	39

Source: Bureau of Meteorology website

Results

Plot counts

From the 2013, 2014, 2016, 2017, 2018 and 2019 surveys, 25 bird species have been recorded from the plot counts. Two species (Woodhen and Pied Currawong) were not generally available for counting in 2019 because the majority of them were being held in captivity at the time of our survey. No analyses for these species were attempted and so they are not included in this report. The White-faced Heron, Buff-banded Rail, Swamphen,

Masked Lapwing, Emerald Dove, Sacred Kingfisher, Golden Whistler, Magpie-lark, Silvereye, Common Blackbird and Song Thrush have been reported from the counts for each of the survey years. Welcome Swallow has been reported for all surveys apart from 2013 whilst the Kestrel was reported for 2014 and 2018. Feral Duck and Feral Pigeon were not reported for 2014. Whimbrel has been reported in 2016, 2017 and 2018. Starling was reported for 2013, 2018 and 2019, Bar-tailed Godwit for 2014 and 2018, Cattle Egret for 2016 and 2017 with Red-necked Stint for 2014 only and Golden Plover and Double-banded Plover only for 2018. New for 2019 was the Tree Martin.

The maximum number of times that any one species could be recorded in 2019 was 383: the sum of 95 plots with four plot counts and one plot with 3 counts. The one missing count from plot number 16 was aborted due to heavy rain. Table 2 shows the distribution of the counts in the vegetation groups and habitat zones.

Table 2. No. of counts in 3 vegetation groups and 5 habitat zones, LHI, 2019

Vegetation group	*Habitat zone*					***Total counts***
	1	*2*	*3*	*4*	*5*	
Lowland forest	103	24	32	16	32	**207**
Palm forest	8	56	8	0	32	**104**
Open	0	32	4	32	4	**72**
Total surveys	**111**	**112**	**44**	**48**	**68**	**383**

Note: For definitions of vegetation group and habitat zone, see Fullagar *et al.* 2019.

Generalized linear mixed models

It is recognized that generalized linear mixed models can be difficult to fit even with well-designed and generally balanced surveys. In the present study the number of random effects contributes to the complexity of the models. The small number of individuals recorded at each plot also adds difficulties to the parameter estimation.

The results of the generalized linear mixed models are summarized with simple statements of the association between rodent control and observed abundances in 2019 and the abundances observed in previous years for each species. Where there was a significant association the potential effect of bait delivery was tested otherwise this effect was not tested.

Buff-banded Rail
There was a significant impact of rodent control on the observed abundance of Buff-banded Rail in 2019 compared with previous years; estimated abundance in 2019 was about 30% of the average abundance in previous years. The log likelihood ratio statistic was 12.1 with 1df ($p = 0.0005$) and there was no effect of bait delivery method on the abundance of Buff-banded Rail.

Swamphen
There was a strong negative effect of rodent control on the Swamphen but no effect of the bait delivery protocol. The log likelihood ratio statistic was 18.1 with 1df ($p = 0.001$).

Masked Lapwing
Only 58 records of Masked Lapwing have been made. Due to an insufficient number of observations no model has been fitted. The majority (54) were from open vegetation. As in earlier years there were insufficient observations of this species to warrant an analysis (Cunningham and Olsen, 2009).

Emerald Dove
There appears to be no impact of rodent control on Emerald Dove abundance. The log likelihood ratio statistic was 3.45 with 1df ($p = 0.06$) and the interpretation of the AIC model based weights supports this conclusion.

Sacred Kingfisher
There appears to be no impact of rodent control on Sacred Kingfisher abundance. The log likelihood ratio statistic was 0.6 with 1df ($p = 0.44$). The AIC based model weights support this conclusion.

Golden Whistler
There appears to be a significant small decrease in Golden Whistler abundance in 2019 compared with previous years of about 13% from an average of 1.1 individuals to 0.97 individuals. The log likelihood ratio statistic was 3.93 with 1df ($p = 0.047$). There is no immediate explanation for this result based on our understanding of the biology of this species. An alternative model where all years were treated as a fixed effect showed no difference between the years suggesting that there is, in general, variability within years that is comparable to or larger than the between year variability.

Magpie-lark
There appears to have been a significant change in the abundance of Magpie-lark due to rodent control. The log likelihood ratio statistic was 6.28 with 1df ($p = 0.01$). The percentage decline is around 50% but note that the average observed abundance pre baiting was 0.08 individuals and post baiting 0.04

Welcome Swallow
The impact of rodent control on the abundance of Welcome Swallow in 2019 compared with previous years was not significant. The log likelihood ratio statistic was 0.27 with 1df

(p = 0.6). The model weights based on the AIC statistics also support this conclusion.

Silvereye
Note that a different mixed model is fitted to the Silvereye data; due to the difficulty of recording abundance the data were converted to presence or absence. It appears there was a significant increase between 2019 and previous years in the probability of occurrence. The log likelihood ratio statistic was 12.3 with 1df (p = 0.0005).

Blackbird
There appears to be no impact of rodent control on Blackbird abundance. The log likelihood ratio statistic was 0.16 with 1df (p = 0.69).

Song Thrush
Only 69 records of Song Thrush have been made from plot observations over all surveys (3.2%) which is below the Cunningham and Olsen (2009) cut off of 5%. Consequently no model has been fitted. The majority of these records (63) are from the Palm forest.

Transect counts

For all transect surveys conducted since 2013 the following species have been recorded; Woodhen, Buff-banded Rail, Emerald Dove, Sacred Kingfisher, Common Blackbird and Song Thrush. For the 2019 transect survey all species seen or heard along each transect were reported (not including Woodhen). The additional eight species (not including Pied Currawong) and the mean number of individuals for each are shown in Table 3. These data are reproduced here in case it is decided to continue with transect surveys into the future.

Table 3. Mean number of nine additional species seen along seven transects in 2019.

Species name	Mean number of individuals
Masked Lapwing	1.33
Whimbrel	1.0
Feral Pigeon	1.0
Golden Whistler	4.39
Magpie-lark	2.23
Silvereye	7.68
Welcome Swallow	3.05
Common Starling	4.5

In six days, seven observers recorded 106 observations with an additional observer also surveying on these days in the opposite direction – resulting in a total of 90 counts for birds on these transects. The additional observer also counted on six mornings from shortly after sunrise following exactly the protocol of the standard evening transect (that is to say not in the reverse direction as that observer had done with evening counts). This gave another 12 counts of bird numbers to compare with evening counts. The speed of travel for all transect counts was standardized to 2 km/hr in 2014 and has been adhered to ever since.
In 2013, before standardization was applied, the average speed was 3.21 km/hr (range 1.94–4.47). In 2014, however, the average speed was 1.90 km/hr (range 1.54–2.16). Consequently, the variance in the speed of travel was significantly reduced (2013 variance 0.42, SD 0.64; 2014 variance 0.01, SD 0.11). The speed of travel in 2016, 2017, 2018 and 2019 was similar to that in 2014.

Based on the comparison of two GLMM fitted to each species a simple log likelihood ratio test allows us to test the impact of the rodent control project undertaken in 2019.

Emerald Dove
There appears to be no impact of the rodent control project on Emerald Dove. The log likelihood ratio test statistic was 2.54 with 1df ($p = 0.11$).

Buff-banded Rail
There was a significant decline in the observed abundance of Buff-banded Rail in 2019 compared to the average of the previous years. The log likelihood ratio test statistic was 2.54 with 1df ($p = 0.11$).

Sacred Kingfisher
There was no significant impact of the rodent control project on the observed abundances of Scared Kingfisher. The log likelihood ratio statistic was 0.32 with 1df ($p = 0.57$).

Song Thrush
There was no significant impact of the rodent control project on the abundances of the Song Thrush. The log likelihood ratio test statistic was 0.38 with 1df ($p = 0.54$).

Blackbird
There appears to have been no impact of the rodent control project on the observed abundances of Blackbird. The log likelihood ratio test statistic was 0.66 ($p = 0.42$).

Discussion

The September 2019 survey started on 10 September; that is just under 9 weeks following the finish of aerial baiting although some hand baiting still continued during our bird survey period. Casual observations during the 2019 survey period indicated that for some species there was an early start to the breeding season but despite this there had been no time between the end of the rodent eradication project and the COG surveys for breeding to

have increased observed population numbers and so influence any recovery from poison effects on non-target species.

One of the important reasons for monitoring landbird populations before the rodent eradication project was to establish some background estimates of selected avian species abundances. We now have five surveys spread over the period 2013 to 2018 to compare with 2019.

Of eleven species from the plot surveys, two (Masked Lapwing and Song Thrush) could not be analysed due to the small number of observations. Four species showed a decline in 2019 when compared with previous years (Buff-banded Rail, Swamphen, Golden Whistler and Magpie-lark) whilst one (Silvereye) showed an increase. The remaining four species (Emerald Dove, Sacred Kingfisher, Welcome Swallow and Blackbird) did not demonstrate a change in abundance after rodent control. None of the species analysed showed a statistical difference in abundance between the two groups of bait delivery methods used, that is, aerial baiting versus other baiting methods.

Of the five species analysed from the transect surveys only the Buff-banded Rail showed a decrease in 2019 compared with previous years. Of the remaining four species (Emerald Dove, Sacred Kingfisher, Song Thrush and Blackbird) none showed a decrease in abundance after rodent control.

The long-term aim of the bird surveys on Lord Howe Island was to document the effects of rodent eradication on the bird communities of the island. The effects of using poison distributed aerially and by hand and through bait stations may have had a direct impact on some non-target species such as the Buff-banded Rail. In addition, the short time frame between poisoning and the bird survey has not allowed any assessment on possible long-term effects on non-target species. With the probability of eradicating rodents the increased food resources and possible increased inter-play between species may well lead to population increases for some species and not others. It is for these reasons that to obtain a picture of the long-term effects in the bird populations it will be necessary to repeat the surveys in 2020 and again in 2021.

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Appendix. Bird species recorded at 96 surveyed plots, LHI, 2019

Species nomenclature and names follow those recommended by the latest IOC listing. See Gill, F & D Donsker (Eds), 2019, IOC World Bird List (v9.2). doi:10.14344/IOC.ML.9.2. For some species we use a simplified alternative in this report.

Name used in this report	*IOC recommended name, if different*	*Scientific name*	*Subspecies*
Feral Duck[1]	Mallard	*Anas platyrhynchos*	
White-faced Heron		*Egretta novaehollandae*	
Buff-banded Rail		*Gallirallus philippensis*	
Swamphen	Australasian Swamphen	*Porphyrio melanotus*	
Masked Lapwing		*Vanellus miles*	*novaehollandiae*
Feral Pigeon	Rock Dove	*Columba livia*	
Emerald Dove	Pacific Emerald Dove	*Chalcophaps longirostris*	*rogersi*
Sacred Kingfisher		*Todiramphus sanctus*	*vagans*
Golden Whistler	Australian Golden Whistler	*Pachycephala pectoralis*	*contempta*[2]
Magpie-lark		*Grallina cyanoleuca*	*cyanoleuca*
Welcome Swallow		*Hirundo neoxena*	*neoxena*
Tree Martin		*Petrochelidon nigricans*	
Silvereye		*Zosterops lateralis*	*tephropleurus*[2]
Common Starling		*Sturnus vulgaris*	
Blackbird	Common Blackbird	*Turdus merula*	
Song Thrush		*Turdus philomelos*	

Note:

1. Includes hybrids with Pacific Black Duck, *Anas superciliosa*. 2. Endemic subspecies