The Whistler

Raptors at Morpeth
Rose Robins in the Hunter
Black-eared Cuckoo mimicry
Birdlife at Belmont Lagoon
Threatened birds in the Hunter
Roosting Oystercatchers at Swan Bay

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- ***To encourage and further the study and conservation of Australian birds and their habitat***
- ***To encourage bird observing as a leisure-time activity***

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Front cover: Black-eared Cuckoo *Chalcites osculans* - Photo: Alan Stuart

Back cover: Rose Robin *Petroica rosea* - Photo: Alan Stuart

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The *Whistler* - Editorial

Publication of the tenth issue of *The Whistler* completes a decade of endeavour which we believe has delivered invaluable documentation of the contemporary status of the bird populations of the Hunter Region. The eclectic collection of articles we have published in that time reflects the unique avian diversity of the Hunter Region. Equally diverse are the backgrounds of authors who have contributed articles. They range from professional ornithologists to bird watchers who had not previously remotely considered the possibility of writing a scientific article. *The Whistler* embodies a culture of regional bird study, which is arguably without peer in Australia. While *The Whistler* feeds off that culture it also nurtures and sustains it by demonstrating the value of conducting systematic field studies and providing participants ownership of their work. Hunter Bird Observers Club Members differentiate themselves from most "Citizen Scientists" by planning, conducting and interpreting their own work rather than waiting in the hope that someone else will eventually find some use for, or explanation of their results.

There have been a number of changes in the taxonomy of Australian birds which we have adopted based on BirdLife Australia's updated working list (V2); http://www.birdlife.org.au/conservation/science/taxonomy (accessed 11 July 2016). Advances in genetic studies continue to provide an improved understanding of linkages across the amazing diversity of our birds. It is important that data collection, analysis and publication of results reflect the latest understanding of that diversity so that it can be protected. Accordingly, we have updated a summary of the status of the Threatened species of the Hunter Region from that previously published in 2010 in *The Whistler* Number 4.

Behavioural studies also feature strongly in this issue involving a number of short notes dealing with topics as diverse as the roost-selection of shorebirds and the fostering of orphaned chicks by wild Laughing Kookaburras. A short paper provides insights into observations 20 years earlier of a most unusual near-coastal breeding of the Black-eared Cuckoo hosted by Speckled Warblers. The explanation provided is only possible because recent studies of the Australian Bronze-Cuckoos have demonstrated how sophisticated the cuckoo-host interaction is in the *Chalcites* genus, to which the Black-eared Cuckoo belongs.

Another short paper provides background to the development of improved distribution maps for the Hunter's bird species. The new techniques are used in this issue's in-depth focus on the Rose Robin.

Raptors are the theme of two articles, both involving long-term studies, one of the Morpeth Wastewater Treatment Works and the other of Port Stephens. There are also notes documenting the breeding of the Black Kite in the Hunter Region and on the tactics of Peregrine Falcons hunting shorebirds. Other articles chronicle the waterbirds of Belmont Lagoon and discuss the Oystercatchers and White Ibis of Port Stephens.

We have our second book review and sadly our first obituary. Max Maddock left us with the legacy of the Wetlands Centre, and his example and leadership, especially regarding the study of egret species, provided the first steps in community-based collaborative bird study which is the hallmark of the Hunter Bird Observers Club and the foundation of *The Whistler*.

During 2016 we have been delighted that Neil Fraser has joined *The Whistler* editorial team. Neil's presence in the Hunter is increasingly important with Mike and Harold residing in Tasmania and Cambridge, UK respectively and Liz cruising the high seas for an extended period. We started by reflecting on how genetics has changed taxonomic understanding; the internet is making equally dramatic changes in the way we communicate and publish.

We again congratulate all our authors over the last ten years, particularly those without previous experience of the preparation of scientific papers and of handling critical peer review. Our appreciation is likewise extended to the referees that we have used over the decade, and who, by the very nature of the task, are nowhere thanked for the individual insights that they have offered authors and editors alike. Thank you all.

Harold Tarrant and **Mike Newman**
Joint Editors

Farewell to Max Maddock

The birding community of the Hunter Region suffered a great loss with the passing of Professor Max Maddock in July 2016 at age 87. He made an enormous contribution to the community; perhaps most notably for his key role in establishing the now internationally recognised Hunter Wetlands Centre.

The Hunter Wetlands Centre is the spiritual home of the Hunter Bird Observers Club. It provides a venue for our meetings and wonderful grounds where we can introduce new members to a variety of birds. School education programs with a focus on birds and natural history will hopefully foster future generations of bird watchers. The Centre also provides a forum for more social bird-orientated gatherings like the finish of the annual Twitchathon. This amazing wealth of opportunity stems from the vision, inspirational leadership and dogged determination of an exceptional person, Max Maddock. It is fitting we publish this tribute to his passing in *The Whistler*.

Heather, Max's wife, says his life can be categorized in three phases (one might say obsessions); initially athletics, then horses and ultimately birds. Towards the end of the equestrian phase Max leased land at the Wetlands Centre site for his horses and was fascinated by the egrets, attracted by the periodic flooding. The egrets inspired not only the concept of the Wetlands Centre, but Project Egret Watch, a community project embracing all of Eastern Australia and even New Zealand.

Paddy Lightfoot provides the following account of the genesis of the Wetlands Centre.

"In 1983 I was on the committee of the Newcastle Group in The Society for Growing Australian Plants – now the Australian Plants Society. The Committee had received a letter from a certain Professor Max Maddock in the Education Faculty at Newcastle University.

"Professor Maddock in his letter had requested that our Group attend a meeting in the Environmental Field Study Centre, Dudley to discuss an idea he had to purchase a property in Sandgate. He proposed to build an Environmental Education Centre on the property.

"Reflecting and knowing Max now I feel that letter may have in fact commanded rather than simply requesting we send a representative.

"The Plant Society suggested, as I was secretary, that I attend the meeting. My brief was that in the event this very unlikely project was to proceed only Australian Native Plants be planted around the proposed environmental centre.

"We attendees sat in a circle around the room. Max, whom I had never met before or whom I had never even heard about, introduced himself. He asked us individually to stand and explain to the group who we were and why we were there.

'Paddy Lightfoot from the Society for Growing Australian Plants. Our group want to ensure that only Australian Plants be used in your proposed project'.
'Right you are on the Landscaping Committee'.
I wasn't sure that I had heard Max correctly! He did not know me – we had just met. He did not ask, 'Would you like to be?' or 'Have you the time to be?'

"The site he had in mind was the defunct Hamilton Marist Rugby Club – the Club had made two mistakes. They developed playing fields away from their supporter base and breathalysers had been introduced in 1981. The Club was in liquidation.

"As the events unfolded in the years ahead, Max with extraordinary vigor and strength of mind managed to bring most of Neville Wran's NSW Government to

Newcastle and persuaded them that the project was worthwhile. As Max said it was a goer - and his dream of an Environmental Education Centre could become a Bicentennial Project for Newcastle and for education. Max then persuaded the Newcastle City Council to rescind their motion to extend the nearby Astra Street dump over the Marist Rugby Club land and to re-route Motorway 23 to by-pass the Club land instead of through it."

The Hunter Wetlands Centre is unique within Australia in providing an environmental hub in the middle of an industrial city. It is amazing that a single entity has an educational function, is a bird observatory in an internationally acclaimed wetland and a field study centre with projects embracing the spectrum of natural history.

Max was the ultimate communicator, as exemplified by Project Egret Watch. He recruited teams of Hunter volunteers to band and tag egrets, both at the Wetlands Centre and at Seaham Swamp near his home. This was expanded to something akin to a small empire by the early 1990s with Max securing funding to employ a full-time Project Egret Watch coordinator. Banders were now tagging egrets under the Project Egret Watch banner at nine coastal breeding colonies from Seaham north to Bundaberg as well as in the Macquarie Marshes in inland NSW. He then recruited observers throughout Eastern Australia to seek and find where the egrets went when they departed from their breeding colonies. Records were obtained from as far afield as southern Tasmania, South Australia, and even New Zealand. Max sustained his collaborators by continual feedback on the value and meaning of their sightings. To put this achievement into perspective one has to appreciate this was happening before the advent of email and today's instant communication systems (those were the days of snail mail). Seldom has a project been sustained in such a personal manner; his observers were valuable collaborators not today's anonymous citizen scientists. Again we draw on Paddy Lightfoot's recollections to grasp the essence of his style.

"Birds seemed to have an affinity for Max. When he visited Seaham Egret Colony the birds stayed placidly on their nests – they recognized him wandering around with his telescope or binoculars, camera slung around his neck and note book. Any other birders visiting and the nesting colony erupted.

"I well remember the egret tagging sessions for his Project Egret Watch – thoroughly wet, mud and bird poo covered – Max in his zenith! He even taught surgical non-slip knots to those helping to attach tags to the birds.

"Max had a network of tag watchers around Australia – one couple reported being approached by the police wanting to know why their binoculars were trained on a farmhouse – the sceptical men in blue took some persuading that they had their binoculars trained – on a number – on a tag – on a wing – on a bird – on a dam in front of the farmhouse!"

Max's concern for his egrets progressively expanded to concern over their wetland habitats in the Hunter Estuary and beyond. He became deeply involved in the RAMSAR process for the wise management of wetlands. Increasingly disillusioned by regulators' blatant disregard for wetlands, which were all too frequently seen as cheap and convenient land for industrial development, he became a passionate advocate for their conservation. Monumental dissertations were prepared, but of course they have to find their highly buffered target audience. Heather describes how Max, now past his prime, gate-crashed a visit by Peter Garrett, the Federal Minister of the Environment, to hand deliver his personal submission on the plight of the Hunter wetlands. It is fair to claim that the outstanding ongoing examples of wetlands rehabilitation and environmental advocacy, for which the Hunter Region is being increasingly renowned, stem from the awareness and culture Max generated. He encouraged some outstanding disciples including many members of the Hunter Bird Observers Club.

Science-based evidence is the prerequisite of effective conservation and advocacy. Again Max provides a role model with his peer-reviewed publications on his egret studies, becoming an acknowledged expert on herons and related species. Sadly, we have only one paper by Max in *The Whistler* "Breeding population decline in Cattle Egrets nesting at Seaham Swamp Nature Reserve and the Hunter Wetlands Centre Australia." The cover of this issue, Number 5, appropriately shows a Cattle Egret resplendent in its breeding plumage. We were privileged because that was the last formal paper Max produced. If Max was writing this his message would be: "Get your work written up while you can, time is short!"

While Max's ornithological productivity may have diminished in his final years his love of birds and fascination with their behaviour blossomed. An astonishing variety of birds were photographed in his small garden at Ashtonfield, attracted by native shrubs and supplied with copious quantities of meal worms. Can Superb Fairy-wrens suffer obesity? Max always tried to find patterns in and explanations for their antics; his mind inquisitive to the end.

Thanks Max for your legacy and to Heather for your support and encouragement of this remarkable person.

Compiled by Mike Newman drawing on the recollections of Paddy Lightfoot, Kevin McDonald, Brian Gilligan and David Geering.

Raptor observations at Morpeth Wastewater Treatment Works (2001-2015)

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Morpeth Wastewater Treatment Works (MWTW) and surrounding ephemeral flood plain provide excellent habitat for a range of raptor species. 16 species were detected during 178 morning surveys conducted at monthly intervals between 2001 and 2015. Although some of these species were recorded frequently, few appear to breed within the immediate vicinity of MWTW, and most observations involved single birds or pairs. The frequency of raptor observations dropped significantly during the 15-year study, suggesting a decrease in local abundance, but the diversity of species recorded remained constant. It is suggested that the apparent decrease in abundance primarily involved frequently observed species such as Whistling Kite *Haliastur sphenurus*, White-bellied Sea-Eagle *Haliaeetus leucogaster* and Swamp Harrier *Circus approximans*.

Temporal analysis suggested that Whistling Kite and Nankeen Kestrel *Falco cenchroides* decreased and similar trends were apparent when BirdLife Australia's Birdata area surveys for the Hunter Region were compared. Trends for other species were more complex, but in general there was good correspondence between the MWTW and Hunter Region trends. This highlights the potential for long-term survey sets conducted in a standardised manner to be used in monitoring raptor populations. In this case the survey program was primarily designed to estimate waterfowl and shorebird populations using the wetlands at and in the vicinity of MWTW.

Between 2001 and 2015 the volume of water processed at MWTW increased, resulting in more extensive and persistent flooding of adjacent ephemeral wetlands. Any positive impact for raptors from this change may ultimately be offset by the rapid encroachment of urban development at the perimeters of the flood plain.

The Black Falcon *Falco subniger*, an inland species generally rare in the Hunter Region, was regularly observed between 2004 and 2008, with circumstantial evidence of breeding, which is unprecedented close to the NSW coast.

INTRODUCTION

Morpeth Wastewater Treatment Works (MWTW) owned by the Hunter Water Corporation (HWC) ($32^0$44'31"S, $151^0$37'24"E) is located about 10 km north-east of Maitland in NSW, approximately 1km from the Hunter River. MWTW covers an area of 72 ha. The original plant, decommissioned in 2000, was a biological filtration works constructed in 1936.

It was recognised that the maturation pond system associated with the original operation constitutes important wetland habitat of local, regional and state significance. As a condition of the Minister's Approval for decommissioning the plant HWC was required to manage the ponds so as "to provide enhancement of wetland and riparian habitats and encourage their use by indigenous and migratory species" (Anon. 2000). In addition to providing habitat for wetland birds the MWTW regularly attracts raptor species, which are the subject of this paper.

A previous paper (Lindsey & Newman 2002) described the survey methods. Subsequent papers have provided an analysis of the occurrence of the herons, spoonbills and ibis (Newman & Lindsey 2011a) and shorebirds (Newman & Lindsey 2011b) during the first ten years of the study.

METHODS & ANALYSIS

Surveys were conducted monthly between February 2001 and December 2015, usually involving two observers. Surveys commenced about 1 hour after sunrise and lasted three to four hours, thus sampling a

range of temperature and wind conditions. Observations were made from or in the vicinity of a car.

MWTW comprises a large area of ponds separated by dykes. The surrounding area is predominantly open farmland, which is intermittently flooded. During this study the volume of wastewater treated increased, resulting in more extensive and persistent flooding of ephemeral wetlands on adjacent farmland. **Figure 1** shows MWTW and surrounding wetlands. There is relatively little woodland. The open conditions were ideal for viewing raptors over distances which were sufficiently large to overcome any bias caused by the presence of observers. However, the periodic presence of raptors disrupted the waterfowl and shorebird populations and was detrimental to estimating their numbers, which was the primary purpose of the surveys.

Figure 1. Morpeth Wastewater Treatment Works shown from the entrance to the treatment plant looking down over the decommissioned maturation ponds in the foreground. The adjacent flooded farmland with a belt of trees is shown in the middle ground, with newly constructed suburban dwellings on the far slope. The photograph was taken under flood conditions in January 2016.

Annual and seasonal occurrences were compared as reporting rates (RR), the frequency of occurrence expressed as a percentage.

Variations in annual RR at Morpeth were compared with those for the entire Hunter Region using area survey data from BirdLife Australia's (BLA) Birdata archive. In making this comparison there is a trade-off between the routine survey style, but small sample size of the Morpeth data and the large sample size, but non-standard effort in BLA Birdata surveys. The significance of the trends discussed below was tested at the $p = 0.05$ level assuming linear correlation. The Hunter Region trends tended to have a higher level of statistical significance, consistent with their larger sample size compared with MWTW.

The MWTW surveys are part of the Hunter Region Birdata set evaluated in 2015 for the period 1998-2014 to provide statistics for the Hunter Region Annual Bird Report (Stuart 2015). Using the results of the existing evaluation is convenient, but may have limitations. For instance, inclusion of the more structured Morpeth results (constant survey effort spread evenly throughout the year) may influence the trends observed elsewhere in the Hunter Region. However, as indicated during the presentation and discussion of results in the following sections the size of the MWTW data set relative to the number of area surveys throughout the Hunter Region is small. Hence, the contribution of the MWTW data has little influence on the Hunter Region's annual RRs and their trends, particularly for the frequently observed and widely distributed raptor species. Consequently, we did not consider the complex re-evaluation of the Hunter Region data needed to exclude the MWTW surveys was justified. Indeed, it can be argued they should not be removed as the MWTW surveys are an important part of the unstructured area survey data set, which is the basis of our knowledge of the current status of the Hunter Region's raptors.

The situation is more complicated for the uncommon raptor species because Hunter Region RRs were calculated using area survey data only from the known range of each species for the period 1998-2014 and ignoring survey effort in other areas of the Hunter Region. Calculation in this manner exaggerates the frequency of occurrence of uncommon species relative to common raptor species, which has implications for the interpretation of results in the following sections.

RESULTS

Over the 15-year period 16 raptor species were seen (**Table 1**), mostly as single birds and only in two species were more than three individuals present. Three species, White-bellied Sea-Eagle *Haliaeetus leucogaster*, Whistling Kite *Haliastur sphenurus* and Swamp Harrier *Circus approximans* were seen regularly, with RRs exceeding 48%, more than twice the next most frequently seen species, Nankeen Kestrel *Falco cenchroides* (RR 22.5%). All five falcon species that regularly occur in the Hunter Region were intermittently present, each occurring in nine or more different years. The White-bellied Sea-Eagle, Australian Hobby *Falco longipennis* and Black Falcon *Falco subniger* were suspected to have bred locally (Newman & Lindsey 2007). The Black-shouldered Kite *Elanus axillaris* was the only other species which occurs regularly, being present during 12 years at an RR of 16.3%. The remaining six species, Square-tailed Kite *Lophoictinia isura*, Black Kite *Milvus migrans*, the three *Accipiter* species and Spotted Harrier *Circus assimilis* were infrequent visitors, being seen in four or less years.

Two measures were used to assess whether the occurrence of raptors as a group had changed over the 15-year period. The number of raptor species

Table 1. Summary of raptor sightings at Morpeth Wastewater Treatment Works during 178 monthly surveys between February 2001 and December 2015.

Raptor species		**Reporting Rate (%)**	**Years seen**	**Maximum number**	**Average number***
Black-shouldered Kite	*Elanus axillaris*	16.3	12	2	1.2
Square-tailed Kite	*Lophoictinia isura*	1.1	2	1	1
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	49.4	15	3	1.4
Whistling Kite	*Haliastur sphenurus*	73.0	15	9	1.6
Black Kite	*Milvus migrans*	3.4	2	1	1
Brown Goshawk	*Accipiter fasciatus*	2.8	2	1	1
Collared Sparrowhawk	*Accipiter cirrocephalus*	1.1	1	1	1
Grey Goshawk	*Accipiter novaehollandiae*	0.6	1	1	1
Spotted Harrier	*Circus assimilis*	0.6	1	1	1
Swamp Harrier	*Circus approximans*	48.9	15	3	1.3
Wedge-tailed Eagle	*Aquila audax*	2.8	4	2	1.6
Nankeen Kestrel	*Falco cenchroides*	22.5	14	3	1.2
Brown Falcon	*Falco berigora*	11.8	13	2	1.1
Australian Hobby	*Falco longipennis*	14.0	13	2	1.1
Black Falcon	*Falco subniger*	12.4	9	4	1.8
Peregrine Falcon	*Falco peregrinus*	9.6	11	1	1

*Average number recorded when present.

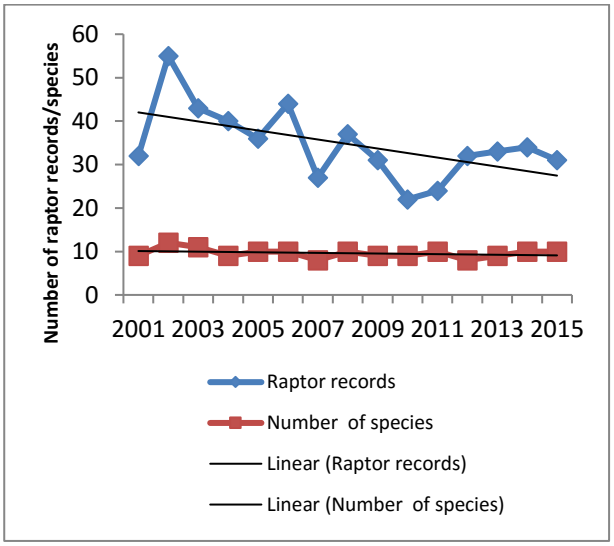

Figure 2. Variation in the annual occurrence of raptors during monthly surveys at MWTW between 2001 and 2015. Raptor records are the number of occasions raptors were present during monthly surveys (i.e. one species may be seen up to 12 times during the year if present during every monthly survey).

recorded during the year was used as an index of diversity. This measure showed little variation between years (**Figure 2**), with a range of 8 to 12 and an average of 9.6 species/annum. The total number of raptor records during the monthly surveys was used as a measure of raptor abundance. In this case the linear trend indicated a statistically significantly decrease (p <0.01) of approximately one third had occurred (**Figure 2**). In the expectation that the cause of this decrease was dominated by changes involving the three most frequently recorded species, variations in their annual RRs were evaluated.

As anticipated there was a statistically significant (p <0.01) decrease in the RR of the Whistling Kite, the most frequently observed raptor at MWTW (**Figure 3**). For comparison purposes variation in RR for the Whistling Kite in Hunter Region area surveys is shown in **Figure 3.** The linear trend line is statistically significant at the p <0.05 level.

The trends of the White-bellied Sea-Eagle and Swamp Harrier are shown in **Figures 4** and **5** respectively. The modest statistically significant (p <0.05) increase in the occurrence of the White-bellied Sea-Eagle at Morpeth was in contrast to the slight decrease in the Hunter Region, which was not significant. In contrast there was a slight decline in the occurrence of the Swamp Harrier at Morpeth, whereas it appeared to increase slightly in the Region, neither of these trends being statistically significant.

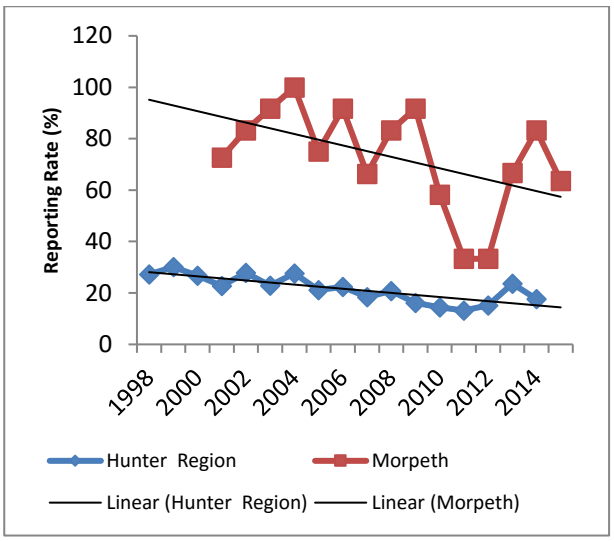

Figure 3. Annual occurrence of Whistling Kite at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The Whistling Kite observations at MWTW contributed 6.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from to 18.4 to 19.6%.

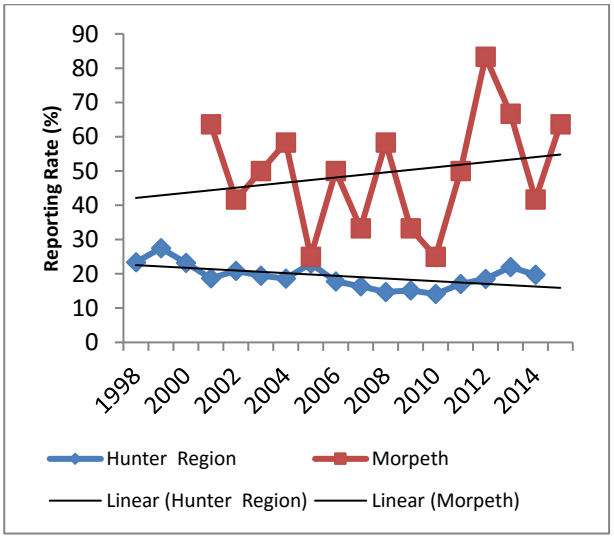

Figure 4. Annual occurrence of White-bellied Sea-Eagle at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The White-bellied Sea-Eagle observations at MWTW contributed 4.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 17.8 to 18.4%.

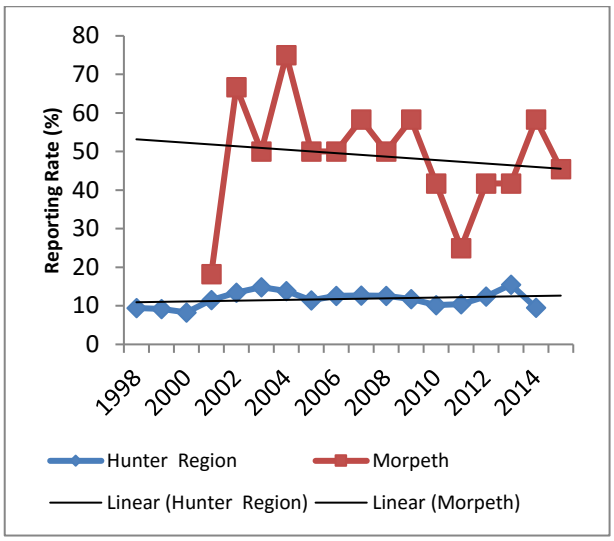

Figure 5. Annual occurrence of Swamp Harrier at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The Swamp Harrier observations at MWTW contributed 7.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 11.9 to 12.6%.

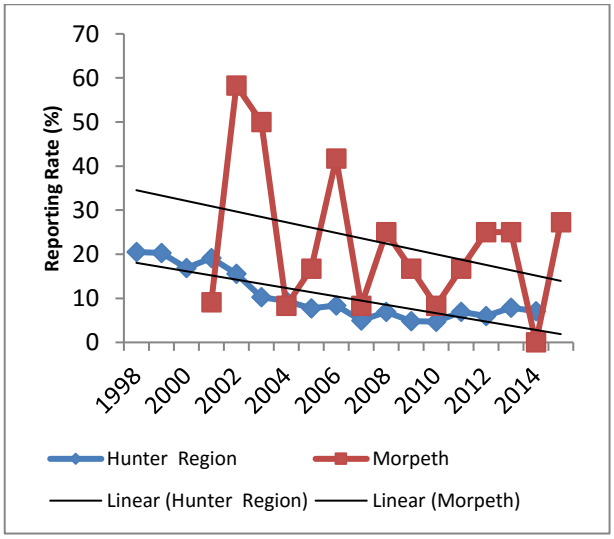

Figure 6. Annual occurrence of Nankeen Kestrel at MWTW during monthly surveys compared with reporting rates Birdata area surveys for the Hunter Region. The Nankeen Kestrel observations at MWTW contributed 3.9% of the Hunter Region records for the period 2001-2014 increasing the RR for that period from 8.4 to 8.6%.

Comparisons of the MWTW and Hunter Region RR trends for the Nankeen Kestrel are shown in **Figure 6**. Both trends indicate a decrease, the Hunter Region trend being statistically significant (p <0.05). The variation in the occurrence of the Black-shouldered Kite at MWTW (**Figure 7**) was more complex, being frequently recorded during the initial two years of the study, then becoming uncommon, with a slight recovery towards the end.

The Hunter Region trend also had a curvilinear appearance, with RRs at decreased levels between 2004 and 2011.

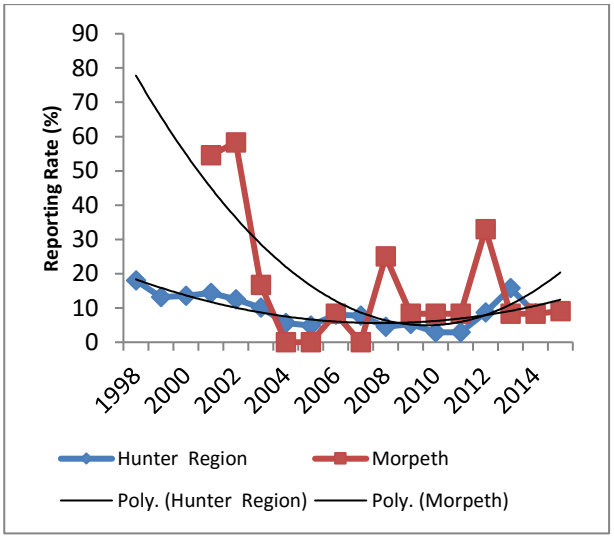

Figure 7. Annual occurrence of Black-shouldered Kite at MWTW during monthly surveys compared with reporting rates for Birdata area surveys for the Hunter Region. The Black-shouldered Kite observations at MWTW contributed 3.2% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 8.3 to 8.4%.

Black Falcon RRs peaked at MWTW between 2004 and 2008 (**Figure 8**). It was frequently recorded in 2005 and 2006, when there was evidence of local breeding involving the feeding of dependent young at MWTW (Newman & Lindsey 2007). There were insufficient Birdata area survey records to provide a Hunter Region trend for comparison.

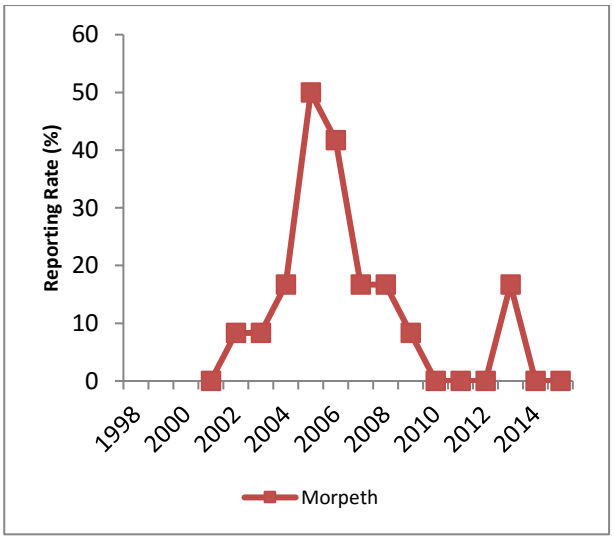

Figure 8. Annual occurrence of Black Falcon at MWTW during monthly surveys.

Collectively the seasonal occurrence of raptors (raptor records) was constant, except for a decrease between August and October (**Figure 9**). There was only minor seasonal variation in diversity with on average 10 species observed each month and a range of 8 to 12 (**Figure 9**).

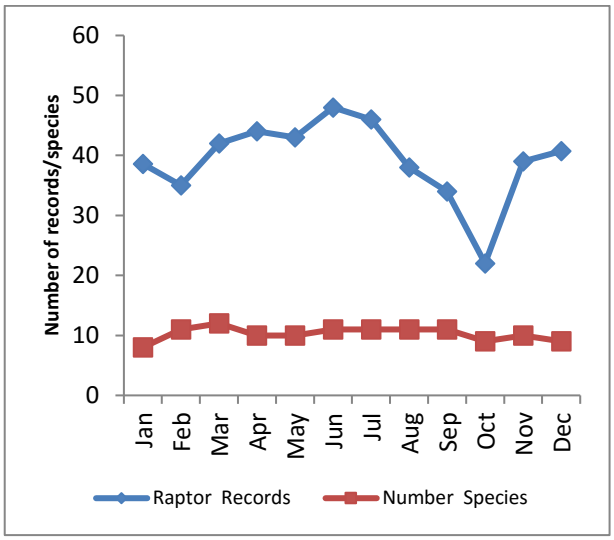

Figure 9. Variation in the seasonal occurrence of raptors during monthly surveys at MWTW between 2001 and 2015. Raptor records are the number of occasions raptors were present during monthly surveys (i.e. one species may be seen up to 15 times during the study). Number of species is the number of species present during at least one survey during the month.

The seasonal occurrence of the Whistling Kite, Swamp Harrier and White-bellied Sea-Eagle are compared in **Figure 10**. The Swamp Harrier showed the most seasonal variation, being more frequently observed between January and August. There was little seasonal variation in the presence of the other two species, apart from the abnormally low occurrence of the White-bellied Sea-Eagle in October.

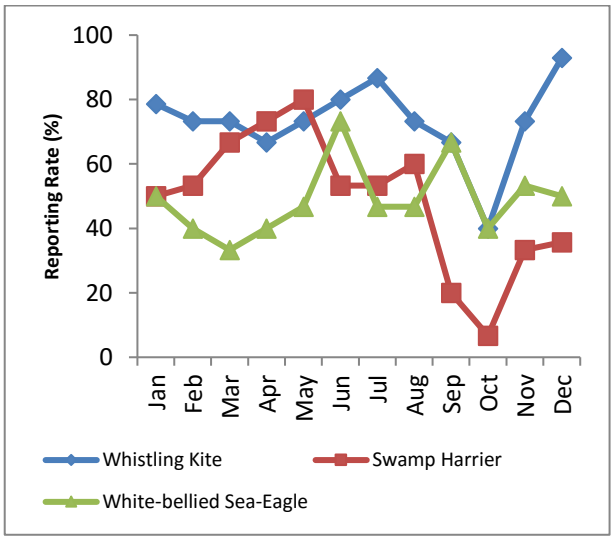

Figure 10. Seasonal occurrence of Whistling Kite, Swamp Harrier and White-bellied Sea-Eagle at MWTW during monthly surveys between 2001 and 2015.

There were similarities in the seasonal occurrence of the Nankeen Kestrel, Black-shouldered Kite and Black Falcon (**Figure 11**). This involved a complex pattern in which there was increased occurrence during the periods April to July and to a lesser extent from November to January and a marked absence between August and October.

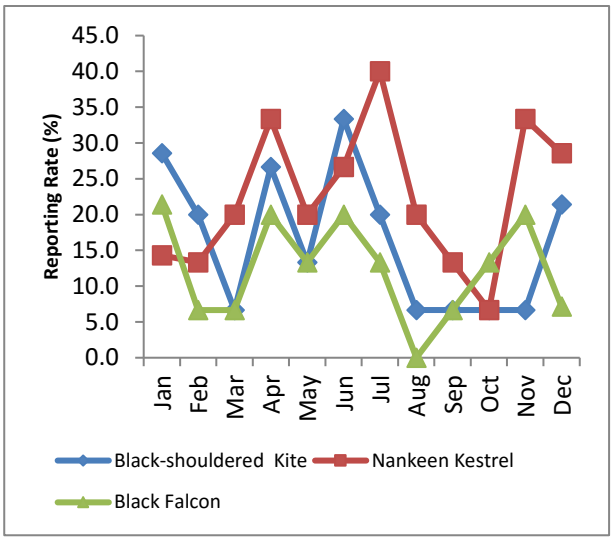

Figure 11. Seasonal occurrence of Black-shouldered Kite, Nankeen Kestrel and Black Falcon at MWTW during monthly surveys between 2001 and 2015.

DISCUSSION

Sixteen of the 21 raptor species which have been recorded in the Hunter Region (Stuart 2015) were recorded during this study, illustrating the importance of MWTW and surrounds to birds of prey. Eleven raptors had RRs which were higher than for the Hunter Region over the corresponding period. To illustrate this point we constructed **Figure 12**, which ranks the raptor species according to their RR ratio (MWTW/Hunter Region).

In attempting to understand the differences in RR ratios it is important to appreciate that the survey effort at MWTW is thought to be higher and more evenly spread throughout the year than for the BLA area surveys where the survey effort is unknown. For discussion purposes we arbitrarily suggest that the survey effort at MWTW may have been two to three times that for the average Birdata area survey. On this basis five species with ratios in the range 1.9 to 2.8 were being seen at approximately the same frequency as elsewhere in the Hunter Region, and six species with ratios greater than 3 were being observed more frequently than would be expected based on survey effort. Conversely, the four species with ratios of less than one were less frequently recorded at MWTW suggesting the area surrounding the survey site does not provide suitable habitat. It also needs to be remembered that by calculating the RR of raptors with restricted range using only surveys within their known range we have inflated the magnitude of their RRs by ignoring surveys in areas where they do not occur.

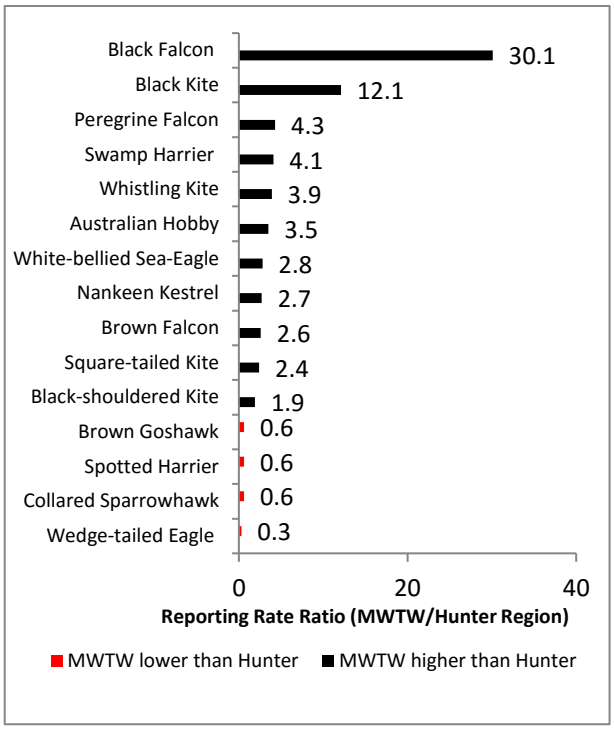

Figure 12. Comparison of occurrence of raptors at MWTW with the Hunter Region. (Hunter Region data based on BLA Birdata area surveys for the period 2001-2014 with MWTW surveys extracted). Reporting Rate ratios greater than 1.0 indicate that a species was seen more frequently at MWTW than elsewhere in the Hunter Region.

High Reporting Rate ratios (>3)

The six species falling in this category may be attracted by local abundance of food both at the MWTW and in the surrounding area (e.g. the MWTW observations involve the movements of raptors to favoured feeding locations). For instance the presence of shorebird species, which occur at MWTW, is known to attract Black Falcons *Falco subniger*, and we witnessed a Black Falcon predate a Curlew Sandpiper *Calidris ferruginea* (Newman & Lindsey 2009). Peregrine Falcon and Australian Hobby were observed hunting flocks of Rock Doves *Columba livia*, which are numerous in the Morpeth area. Swamp Harriers regularly hunted over a partially drained pond at MWTW, where waterfowl and migratory shorebirds shelter among vegetation. Pacific Black Duck *Anas superciliosa* were among species targeted (Newman 2011). Whistling Kites fed on

partially digested grain floating on the surface of the treatment plant process tanks, during a period when there was a build-up in their numbers (Shaun Clewes pers. comm.). Observations of the Black Kite probably reflect the movement of individuals joining the much larger numbers which regularly scavenged at the nearby Maitland municipal tip. Local breeding is another reason a raptor species might have an elevated RR at a regularly monitored site like MWTW. For instance, in Victoria Brown Falcon pairs have home ranges of 1.5 to 2 km^2, but defend a much smaller area of about 500m radius about the nest site (Marchant & Higgins 1993). We suspect that Black Falcon and probably Australian Hobby have nested in the area surrounding MWTW based on the observation of adults feeding dependent young (Newman & Lindsey 2007), nests and courtship behaviour respectively.

The exceptionally high RR ratios for the Black Falcon and Black Kite reflect the restricted distribution and discontinuous occurrence of these species at MWTW and in the Hunter Region (BLA Birdata records) during the study period 2001-2015.

Normal Reporting Rate ratios (1.9 to 2.8)

Five species have RR ratios which the authors consider to be typical for their range in the Hunter Region. Like the species discussed above they are often observed in the open country of the Hunter Estuary flood plains surrounding MWTW. A nest and dependent young suggests that the White-bellied Sea-Eagle breeds in the ephemeral wetlands adjacent to MWTW. Nankeen Kestrel, Brown Falcon and Black-shouldered Kite are species which favour the open country of the Hunter Estuary flood plains, and their occurrence at MWTW is typical for the area. In contrast the Square-tailed Kite prefers woodland habitat. Its occurrence at MWTW is attributed to its regular occurrence in the Maitland area, which is one of the few areas in the Hunter Region where this species is frequently recorded.

Low Reporting Rate ratios (<1.0)

Six species, including three *Accipiter* species, fall in this category if the Grey Goshawk *Accipiter novaehollandiae*, which was recorded in 2015, is included (the **Figure 12** analysis only considered records for the period 2001-2014, because of the lack of Hunter Region Birdata for 2015 at the time of writing). *Accipiters* primarily forage in woodland and the Grey Goshawk is regularly mobbed when away from cover. The occurrence of this species at MWTW illustrates the need for woodland birds to move through open country between the ever-decreasing areas of remnant woodland in the Morpeth area. The infrequent occurrence of the Wedge-tailed Eagle *Aquila audax* and the absence of any Little Eagle *Hieraaetus morphnoides* records were unexpected. In the authors' experience both these species occur occasionally in open country elsewhere on the edges of the Hunter River flood plain (e.g. Pambalong Nature Reserve, Hexham Swamp and Woodville), which are nearer than MWTW to the vegetated foothills adjacent to the Hunter Estuary flood plains.

Status and Seasonal Variations

Bird populations experience natural fluctuations in status and in long-lived species like raptors these cycles may be long-term. In addition, Hunter Region populations may be temporarily increased by influxes of birds from other regions following adverse environmental conditions like drought in the interior of Australia. Consequently, we do not know whether the Hunter Region's raptor populations were at normal (average) levels when this study commenced in 2001 or even if the populations are stable. Indeed there are indications that some raptor species may be experiencing long-term decline (Cooper *et al.* 2014).

During the 15 years there was no obvious variation in either annual or seasonal diversity of raptor species visiting the area (**Figures 2** and **9**). However, the total annual number of raptor observations, an indicator of the abundance of raptors, declined by approximately one third (**Figure 2**), mainly as a consequence of a decline in the Whistling Kite (**Figure 3**), the most frequently observed raptor. Swamp Harrier (**Figure 5**) and Nankeen Kestrel (**Figure 6**) also showed evidence of long-term decline, offset by a slight increase in the White-bellied Sea-Eagle (**Figure 4**). The seasonal variation of raptor records, the index of abundance, indicated a slight increase in winter and more pronounced decrease in October (**Figure 9**), which is attributed to species like the Whistling Kite moving away from MWTW during the breeding season, as discussed in the following accounts for the frequently observed species.

Whistling Kite

The decreased RR at MWTW was mirrored by a long-term decline throughout the Hunter Region

(**Figure 3**). However, the occurrence at Morpeth was anomalously low in 2011 and 2012. Monthly RRs increased between January and July, before falling to minimum levels in October (**Figure 10**), which is the main breeding month in NSW (Cooper *et al.* 2014). This suggests that there is a lack of breeding sites in the immediate vicinity of MWTW. The peak levels in December may indicate post-breeding season dispersal.

White-bellied Sea-Eagle

This species increased at MWTW in contrast to a slight decrease in the Hunter Region (**Figure 4**). The increase at MWTW may be associated with the establishment of a breeding pair in the immediate vicinity of the study area. This may be in response to hydrological changes that occurred during the study increasing the extent and permanence of ephemeral wetlands adjacent to the MWTW site. However, urban development is rapidly encroaching on the wetlands, and breeding viability may prove short-term. Cooper *et al.* (2014) have foreshadowed a similar concern about potential loss of viable nest sites throughout coastal NSW. There was no obvious pattern to variations in seasonal occurrence (**Figure 10**).

Swamp Harrier

Both the MWTW and Hunter Region RR trends suggest that Swamp Harrier populations were relatively stable with increases and decreases of approximately 10% respectively (**Figure 5**). RRs increased during late summer and autumn and were lowest during September and October (**Figure 10**). The autumn build-up may be associated with the movement north of birds from further south in Australia. The Hunter Valley is towards the northern end of species' breeding distribution. However, the decreased numbers during September and October, the peak of the breeding season (Cooper *et al.* 2014) suggests that breeding does not occur at MWTW.

Nankeen Kestrel

The long-term trend for the Nankeen Kestrel at MWTW decreased by approximately 50%, but annual variation was erratic (**Figure 6**). There was a similar decrease in the long-term trend for the Hunter Region Birdata area surveys (**Figure 6**). Both data sets show some evidence of a partial recovery post-2010, which is consistent with the findings of Cooper *et al.* (2014). They suggest that the Nankeen Kestrel is adversely affected by drought, and attribute the post-2010 recovery to wetter conditions. Veerman (2003) has suggested that tree plantings may contribute to local decreases, but that is not an issue at MWTW (**Figure 1**), where we have advised against revegetation. The complex seasonal variation in RRs was consistent with the pattern suggested by Cooper *et al.* (2014), involving a combination of partial and altitudinal migration. Decreased occurrence in September and October (**Figure 11**) is attributed to the breeding season peaking in September, with limited nest sites in the immediate vicinity of MWTW.

Black-shouldered Kite

The Black-shouldered Kite was regularly present at MWTW during 2001 and 2002, but its subsequent occurrence was infrequent, with some evidence of increase post-2007 (**Figure 7**). There was a similar decline in the Hunter Region Birdata area survey trend, which decreased in the middle of the study (**Figure 7**). Cooper *et al.* (2014) suggest that long-term trends are driven by decreased breeding during periods of drought and subject to these fluctuations Black-shouldered Kite populations in NSW are relatively stable. Our results are consistent with that conclusion. Lower occurrence between August and November (**Figure 11**) coincided with the peak of the breeding season (Cooper *et al.* 2014).

Black Falcon

Most of the MWTW records occurred between 2004 and 2008 (**Figure 8**) with evidence of breeding in 2005, when an adult fed two dependent young (Newman & Lindsey 2007). There was a further circumstantial indication of breeding in 2006, and it was concluded that the Black Falcons were resident, this being the first evidence of near coastal breeding by this species, which usually breeds to the west of the Great Dividing Range (Cooper *et al.* 2014). However, residence was temporary, with two observations in 2013, the only MWTW records since 2008. There were insufficient Birdata area survey results to draw any conclusions concerning the change in status of this species, which is, with the exception of a few locations, rare in the Hunter Region. In our earlier paper we concluded that the first Black Falcon records at MWTW coincided with drought conditions in the Hunter Valley (see Figure 2 *in* Newman 2012), which caused an abnormal influx of dry country species towards the coast. It also resulted in a build-up of Sharp-tailed Sandpipers *Calidris acuminata*, which together with other shorebird species, are known prey of Black

Falcons (Marchant & Higgins 1993). At MWTW we have observed Black Falcons taking Curlew Sandpiper *Calidris ferruginea* (Newman & Lindsey 2007), Rock Dove and Magpie-Lark *Grallina cyanoleuca.* There were Black Falcon records at MWTW throughout the year, with the exception of August (**Figure 11**). Black Falcons may benefit from agriculture increasing the abundance of prey (Debus 1998) and it is tentatively suggested that irrigation areas adjacent to the Hunter River may have assisted the recently observed spread to the coast.

Value of long-term systematic surveys

An aspiration of this paper was to determine whether a standard survey conducted at regular intervals would provide useful insights into the local status of raptor species and whether the conclusions could be extended to provide useful inferences at the wider regional scale. The analysis presented above provides useful measures of the status of those raptor species which occur commonly in the open areas of the Hunter Estuary flood plain. For some of the frequently observed species changes in local status were apparent.

The MWTW trends usually corresponded with those indicated by the Hunter Region Birdata area surveys (e.g. decreases in the Whistling Kite and Nankeen Kestrel) and in other cases the differences were minor (e.g. White-bellied Sea-Eagle). Consequently, the dual evidence provided by the two data sets reinforces the conclusions drawn independently from the two approaches, both of which have limitations. For instance the Birdata area surveys lack standardisation (i.e. differences in sites, duration, observers and annual survey numbers) and there are concerns that observed trends are affected by variations in survey effort (e.g. number of surveys, survey location and length of surveys). The MWTW surveys eliminate these variables, but sample only one location and habitat type and hence are not representative of the Region. This is illustrated by the potentially anomalous data generated for species which are sparsely distributed in the Hunter Region (e.g. Black Kite, Black Falcon and Square-tailed Kite).

Although not specifically designed for monitoring the occurrence of raptors, the MWTW survey protocol, involving spending an extended period (3 to 4 hours) in an open area with unimpeded vision, had several important attributes. In most instances raptors hunt over a much larger range than the MWTW survey site and its immediate surrounds. Consequently, it is important to survey over an extended period, which includes changes in wind and thermal conditions (i.e. suitable for soaring species). In addition MWTW and its surrounds attract raptors by providing a diversity of prey types, as indicated by the examples provided in the species accounts.

CONCLUSIONS

MWTW and immediate surrounds attract an eclectic set of raptor species, although few occur sufficiently regularly to be considered locally resident. The frequently observed species exploit prey associated with the wetland habitat, including water fowl and shorebirds. Other species like the falcons hunt the open spaces of the adjacent flood plains and benefit from the abundance of introduced species like the Rock Dove.

A statistically significant trend (p <0.05) in observation rates over 15 years suggests that raptors as a guild have decreased at MWTW, although there was no apparent change in species diversity. This suggests that the decreased occurrence of raptors is primarily associated with most frequently observed species.

Whistling Kites and Nankeen Kestrels decreased, consistent with the trend throughout the Hunter Region. White-bellied Sea-Eagles increased, which may have been associated with breeding in the vicinity of MWTW. Other species showed more complex annual variation, but were generally consistent with trends throughout the Hunter Region as indicated by Birdata area surveys. In several instances seasonal RRs of the frequently observed species decreased during their breeding season, suggesting that they do not nest in the immediate vicinity of MWTW.

The RRs for Black Falcons were anomalously high for the Hunter Region, consistent with MWTW being within the home range of a resident pair for several years, with feeding of dependent young providing evidence of breeding. However, decreased RRs during the breeding season (**Figure 7**) suggest that MWTW lies outside the smaller area defended around the nest site when breeding.

The survey method, involving an extended period of 3 to 4 hours of continuous observation in mornings on a monthly basis, proved effective in monitoring raptors, sampling a range of wind and thermal conditions. The results of this study have provided valuable insights into the status of raptors in the Lower Hunter.

ACKNOWLEDGEMENTS

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Insights into Hunter Region birdlife using BirdLife Australia Atlas project data

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The Hunter Region has been classified into 60 mapping areas based on biodiversity and geographical/ topological commonalities. Using data from the BirdLife Australia Atlas project, a Reporting Rate was calculated for each species recorded within each bio-geographic sub-region. Maps have been generated showing Reporting Rate ranges in the sub-regions. These maps complement a previously described approach for showing species distribution within the region. They provide an easily assimilated overview of the general distribution of a species within the region, in particular where the strongholds are and the areas where the species is uncommon. As such, they should prove very useful for a range of educational purposes and as a guide for the vetting of records.

To illustrate the capability of the new approach, maps have been generated for five species with varying distributions within the region: Wonga Pigeon *Leucosarcia melanoleuca*, Crescent Honeyeater *Phylidonyris pyrrhopterus*, Little Eagle *Hieraaetus morphnoides*, Western Gerygone *Gerygone fusca* and Brown Gerygone *Gerygone mouki*.

A method for generating timelines for migratory species using Atlas data has also been developed. The timelines indicate the likelihood of the species being present in the Region on any given date. To illustrate the capability, timeline charts are presented for two species, the White-fronted Tern *Sterna striata* and the Common Tern *Sterna hirundo*. These are generally considered to be winter and summer visitors respectively to the region. The timeline chart for Common Tern reveals that it over-winters at least on occasions.

INTRODUCTION

The current BirdLife Australia (BLA) Atlas project ("the Atlas") commenced in 1998. The first four years (termed the New Atlas) resulted in a published important reference resource for Australian ornithology (Barrett *et al.* 2003). This included a comparison with the Field Atlas (Blakers *et al*. 1984) conducted 20 years earlier. The NSW Bird Atlas (Cooper *et al.* 2015) continued the Field Atlas in NSW. The BLA Atlas data established by the New Atlas has continued to be built in the Ongoing Atlas project. The BLA Atlas differs from previous atlases (Blakers *et al*. 1984; Cooper *et al*. 2015) by using "point" based surveys (i.e. defined by latitude and longitude) and defined ranges of survey effort (e.g. incidental records, 2ha:20 minute surveys and area surveys; Barrett *et al*. 2003).

Many members of Hunter Bird Observers Club (HBOC) are regular contributors to the Atlas and the club actively promotes participation by local birdwatchers. Records from HBOC's field program (outings, camps, focussed surveys) are submitted to the Atlas (involving almost 1,500 surveys).

Commencing 2010, HBOC has received from BLA an annually updated export of all the Atlas records from the Hunter Region since 1998, when the New Atlas phase commenced. Since 2010 Hunter Region Annual Bird Reports have contained summaries relating to the region's resident species and regular visitors (Stuart 2011). For each species, the main Atlas information presented has been:

- Reporting Rate since 1998 which provides an indication of how common (or detectable) it is within its regional distribution.
- The percentage of 10-minute grid cells for which there have been records. This provides an indication of the extent of its distribution.
- For the current year, the number of Atlas records, the Reporting Rate and the number of 10-minute grid cells in which there were records. This allows comparison between the current year and the long-term situation.

The Hunter Region Atlas data have also been analysed in several studies of species or groups of species, for example Williams (2013), Newman & Lindsey (2014), Newman (2015). However, the Atlas database's potential seemed under-utilised. It is based upon over 30,000 surveys in the Hunter Region, comprising more than half a million records of individual species. Thus, it has the potential to be a powerful resource for analysis and education.

In this paper, we describe two new approaches for analysing Hunter Atlas data. One innovation is a method for generating species distribution maps; the other involves producing timelines for when migratory species are present.

METHODS

A Google Earth polygon file is available that precisely defines the Hunter Region boundaries (D. Williams unpublished). A copy of the shapefile is located at http://www.hboc.org.au/resources/hunter-region.kml. BLA extracted every Atlas record falling within the polygon boundary, and supplied them as an Excel file.

Standard mathematical manipulations within the Excel software program were used to produce species timelines. The number of Atlas records for a given species for each week of the year was determined, and then the cumulative frequency distribution of weekly records throughout the calendar year. One of two possible origins was selected – 1 January or 1 July (for winter and summer migrants respectively). Time periods were then classified according to whether their mean numbers of weekly records were within 1, 1.5, 2, 2.5 or >2.5 standard deviations from the overall weekly mean.

To generate distribution maps, the Atlas data were imported into the software program ESRI ArcGIS where they could be overlaid with relevant bio-geographic information which was generated as follows. Using ESRI ArcGIS, the Hunter Region was divided into a set of 60 bio-geographic mapping areas ("polygons"). The selection of each polygon boundary involved careful analysis, with the need to balance several factors:

- Presence of a dominant habitat type within the polygon, also taking into account the extent of clearing of vegetation for residential, industrial or agricultural purposes. Some consideration was also given to other geographical factors including topography, geology/soils, vegetation, and river catchment;
- Sufficient Atlas surveys had been conducted in the polygon – a criterion selected was that there be a minimum of 50 surveys conducted in a polygon (only three of the 60 polygons have less than 80 surveys and most have several hundred);
- If the data set for a polygon was dominated by surveys from a small number of locations, the habitat type at all of these was representative of the overall polygon.

The Atlas records include precise latitude and longitude co-ordinates for each survey, and so they were able to be assigned to the polygon within which they were collected. Then for each species in each polygon, a Reporting Rate index (RR) was calculated:

$$RR = N_R/N_S$$

where N_R is the number of records for the species in the polygon;
and N_S is the total number of surveys in the polygon (including all survey types).

It should be emphasised that the above RR differs from the RR usually used (e.g. in the Annual Bird Reports; Stuart 2011), in that records from incidental surveys are included. Uncommon species are more likely to be reported from an incidental survey, potentially leading to a degree of over-reporting for them. This is balanced by the desirability, for distribution maps, of capturing all known records, especially for uncommon species.

RESULTS

Species distribution mapping

Informative distribution maps were generated by plotting the RRs (as ranges) within each polygon by choropleth mapping, a frequently used method which uses either different colours or a graduated colour scale in order to show value levels in defined areas on a map. Through trial and error, it proved effective to use four ranges of RR (<0.02, 0.02-0.10, 0.10-0.30 and >0.30). Different choropleth range selections might be appropriate in certain circumstances and this would be easily enacted. The lowest range highlighted extremes in the range of a species, and also was useful for mapping the distribution of uncommon species with relatively few records in the Atlas database. For polygons with fewer than three records, those records perhaps require more careful scrutiny and so they were not included into the mapping. At the limits of a species' range (i.e. RR < 0.02) there is a need for further investigation in terms of increased survey effort and validation of records, particularly in polygons with less than three records of a species.

By way of example, **Figure 1** illustrates the distribution map for Wonga Pigeon *Leucosarcia melanoleuca*. The map shows that the most likely

places within the Hunter Region to record Wonga Pigeon are in parts of the Upper Manning, Barrington Southern Slopes and the Wollemi/Yengo Massif, and to the west of Port Stephens and Great Lakes. By contrast, it would be very unusual to find Wonga Pigeons at locations within the Hunter Valley, Merriwa Plateau or Liverpool Plains. For convenience for the above discussion and similar ones, the Hunter Region was also divided into 15 sub-regions, as shown in **Figure 2**. These sub-regions also have common bio-geographic factors and initially were trialled as the basis for choropleth map generation. However, for species with specialised habitat requirements, they were found to be insufficiently detailed. The sub-region boundaries have been retained in the maps as they assist orientation. **Figure 2** includes latitude and longitude graticules for the Hunter Region, which is approximately centred on 32.5ºS 151.5ºE.

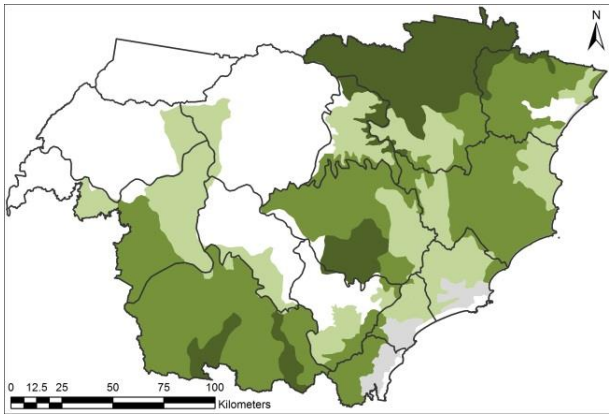

Figure 1. Distribution map for Wonga Pigeon

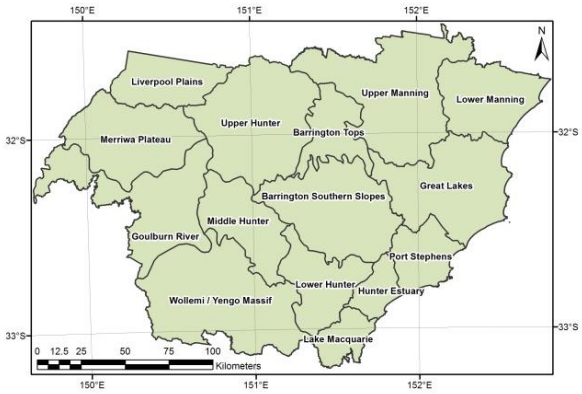

Figure 2. Hunter Region sub-regions

Timelines for migratory species

Data from the Atlas were analysed to generate timelines indicating when each migratory species was likely to be present in the region. Two examples of species timelines are shown in **Figures 3** and **4**, for the White-fronted Tern *Sterna striata* and the Common Tern *Sterna hirundo*. These are considered to be winter and summer visitors respectively to the region (Stuart 2016).

Figure 3. Timeline for White-fronted Tern

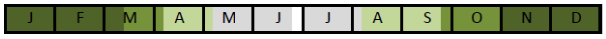

Figure 4. Timeline for Common Tern

DISCUSSION

Species distribution mapping

Maps were generated for four additional species, in order to demonstrate a range of applications of the method. An example of a species with a narrow regional distribution is given in **Figure 5**, for the Crescent Honeyeater *Phylidonyris pyrrhopterus*. **Figure 5** confirms the general view (Stuart 2016) that the local range for this species is limited to the higher altitude area of the Barrington Tops and Gloucester Tops. In contrast, the Little Eagle *Hieraaetus morphnoides*, as an apex predator, is an example of a species having wide distribution and low abundance, such that it is recorded only intermittently. The distribution in **Figure 6** suggests the Little Eagle avoids higher altitude areas.

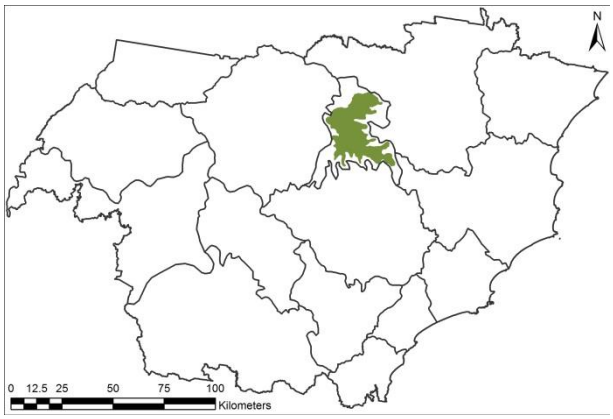

Figure 5. Distribution map for Crescent Honeyeater

Figures 7 and **8** compare the distributions of Western Gerygone *Gerygone fusca* and Brown Gerygone *G. mouki*. These two species are similar in appearance and potentially can be a source of

identification confusion for some observers. The Western Gerygone is generally considered to be an inland species (Stuart 2016). **Figure 7** confirms this, with all records originating from the west of the region and in particular from the Liverpool Plains. In contrast, the distribution for Brown Gerygone (**Figure 8**) is predominantly in the east and central parts of the region. The western records are limited to areas around the Coolah Tops. The two species have almost mirror image distributions within the region, which mapping demonstrates very effectively.

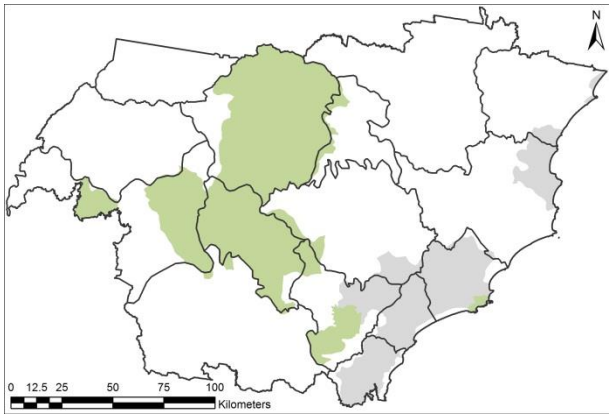

Figure 6. Distribution map for Little Eagle

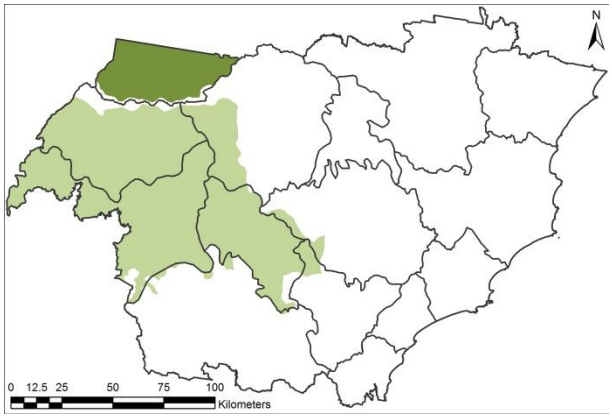

Figure 7. Distribution map for Western Gerygone

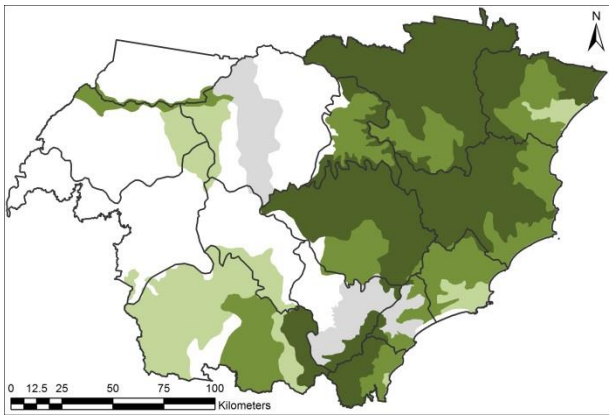

Figure 8. Distribution map for Brown Gerygone

Seasonal distribution maps also can be readily generated. The accompanying paper in this issue (Stuart & Williams 2016) presents summer and winter distribution maps for the migratory Rose Robin *Petroica rosea*.

Comparisons with other mapping approaches

Most maps of species distributions show the Hunter Region at a very broad scale, for example involving 1-degree grids (Blakers *et al.* 1984, Barrett *et al.* 2003). As such, they contribute little to local understandings. Newman *et al.* (2010) developed a more finely detailed approach, producing maps for 42 NSW threatened species in the Hunter Region based on a grid scale of 10 minutes latitude / longitude. Cooper *et al*. (2015) provide distributional information based on the presence of a species at a 10-minute scale, but only show variations in RR at the 1-degree scale. A limitation of the approach used by Newman *et al*. (2010) was that varying survey effort in adjacent 10-minute grid cells sometimes introduced statistical anomalies, which suggested changes in RR that may not have been real. For data-rich common species, this should become less of an issue. The approach used in this paper provides a degree of smoothing which should be beneficial in limiting the impact of anomalies.

Whitehead *et al.* (2015) used records from the NSW Wildlife Atlas plus vegetation, climate and topography data to develop predictive models of species distributions (and thence, identifying high priority areas for conservation). The NSW Wildlife Atlas has a smaller data set than does the BLA Atlas and is arguably less well vetted.

The approach to mapping described in this paper involves a form of predictive modelling. A key assumption is that if a species was recorded at some readily accessible location, it is about equally as likely to be present in adjoining areas of suitable habitat which are less accessible (e.g. on private property). If the other sites are relatively close by, this assumption should generally be valid.

The flexibility of the adopted approach will also enable additional factors to be taken into account, such as RR calculation adjustments based on the proportions of each survey type (2ha, area and incidental) and the seasonal distribution of records within each polygon.

Timelines for migratory species

The comparison of weekly number of records to the mean number of weekly records indicates the likelihood that a species will be present in the region on any given date. It is not a measure of abundance, merely of presence/absence. It is suggested that the ranges are interpreted in the following empirical terms: dark green SD <1.0 from the mean weekly average, birds are regularly present; medium green SD 1.0-1.5 usually present; light green SD 1.5-2.0 sometimes present; grey SD 2.0-2.5 occasionally present; white SD > 2.5 rarely present.

The timeline chart for White-fronted Tern, **Figure 3**, shows that these birds are regularly present from early July to mid-September, usually recorded in May and September and sometimes in April and October. They occasionally are recorded in March, but rarely so in January-February or November-December. From the timeline, observers may discern that records of White-fronted Tern in the periods January-April and October-December are noteworthy and important (and that extra care is therefore needed to correctly identify the species at such times).

For the Common Tern (**Figure 4**), birds are regularly present between January and mid-March and in November-December, and are usually present in late March and in October. However, there are records of them throughout almost all of April to September, albeit far less frequently than in the other six months. Thus while the White-fronted Tern has the characteristics of a winter migrant, the Common Tern is revealed to over-winter at least on occasions, though with a summer influx.

In generating species timelines, two notes of caution need to be recognised:

- A species needs to be already considered a migrant before applying a timeline analysis to it. Some species, which are resident in the region, become less detectable in winter (e.g. they call less frequently) and it may appear that they are absent when in fact they are not. Understanding these variations is another potential application of the method.
- The use of a cumulative frequency approach (rather than the frequency for each individual week) assists to smooth anomalies within the recorded data. However, for less common species (i.e. with fewer records in the database) this may become a limitation.

CONCLUSIONS

Species distribution maps were able to be generated using Atlas records coupled with detailed bio-geographic information. Where the regional distribution was already reasonably well understood, the maps have agreed with general understandings. This gives confidence that they will also be useful in helping develop perspectives about less well understood species.

The Hunter Region hosts many migratory species. Most are "summer migrants" but some are not. Every migratory species has arrival and departure dates which are broadly consistent most years, but those dates can differ substantially from those for other species. Timelines were able to be generated from Atlas data to depict the probability that a migratory species will be present on any given date.

The potential of both these approaches in educating birdwatchers as to where and when a species is most likely to be found within the Hunter Region (and, conversely, when records could be considered anomalous) is obvious. It is intended that future Hunter Region Annual Bird Reports will include distribution maps for common species and timelines for migratory species. The availability of this information should assist in vetting records.

When sufficient data becomes available, both the distribution maps and timeline charts may be applied to comparisons between different sets of years, to provide insights into changes over time. Also, the timeline analyses potentially may be applied to sub-regions, generating additional insights.

ACKNOWLEDGEMENTS

Our thanks go to Mick Roderick and Ann Lindsey for various helpful discussions. An anonymous referee also made several helpful suggestions. We also acknowledge BirdLife Australia for providing records from the Atlas database and the strong support we have received throughout from Andrew Silcocks, the Atlas project manager. BirdLife Australia has data exchange arrangements with other organizations including the New South Wales Bird Atlassers and the use of the latter's 1998-2001 Hunter Region records is acknowledged.

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Rose Robins in the Hunter Region

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The distribution, relative abundance and seasonal movements of the Rose Robin *Petroica rosea* in the Hunter Region have been reviewed, using records over 1998-2015 from the BirdLife Australia Atlas project database supplemented by incidental records from annual bird reports for the region.

A distribution map was generated, which showed that Rose Robins were absent from much of the western parts of the region and from heavily cleared areas, but relatively common everywhere else. There were marked differences in the distribution pattern in the region depending upon the season. Timelines were produced showing when the species was recorded at locations above and below 400m elevation. These timelines suggest that the Hunter Region's Rose Robins make an altitudinal migration each year. They seem to remain within the region, but birds mostly have been recorded at low altitudes in the period between late April and mid-August and at high altitudes in the rest of the year.

The annual Reporting Rates from the BirdLife Australia Atlas project were calculated. These showed that although the status of the local population of Rose Robins has been maintained in the long term (i.e. over the 18-year period of the Atlas), it has varied markedly in some years apparently in response to climatic conditions. A large population increase occurred in 2003 following a three-year La Niña event and a large population decrease occurred in 2009 following several years of El Niño drought. The increase in 2003 was statistically significant at a 95% confidence level.

Local breeding records have been documented. All the records were from mid to high altitude locations within the region, confirming a breeding pattern noted elsewhere within the Rose Robin's range.

INTRODUCTION

The Rose Robin *Petroica rosea* in some respects is a special bird of the Hunter Region as the first documented specimen was collected locally by John Gould in about 1839 (Higgins & Peter 2002). It is an insectivore, mostly recorded as single birds and pairs within its range in south-eastern Australia. Its stronghold is the temperate woodlands on the eastern slopes of the Great Dividing Range (GDR) but its range extends to the western slopes of the GDR and north to about Rockhampton (Higgins & Peter 2002). In spring-summer, birds mostly are found in wet sclerophyll forests, moving to drier, more open habitats in autumn-winter (Higgins & Peter 2002).

Rose Robins are generally accepted to be a migratory species but there is a degree of uncertainty about the migration pattern. Griffioen & Clarke (2002) analysed large data sets for broad movement patterns and concluded that there was strong evidence for a "mid East Coast" movement by Rose Robins, with birds from NSW moving northwards along the eastern coast. However, they also noted (in comments about migration patterns in general) that the broad pattern in evidence for a species did not necessarily apply to the entire population. Higgins & Peter (2002) analysed anecdotal evidence and concluded there was variability in the extent to which Rose Robin movement was an altitudinal migration or involved dispersal northwards, and in some areas birds were even considered to be sedentary (Higgins & Peter 2002). In the Hunter Region, Rose Robins are considered relatively common and to make an altitudinal migration (Stuart 2015). That assessment was based on incidental observations by members of Hunter Bird Observers Club over several decades. The recent availability of data for the Hunter Region from the BirdLife Australia (BLA) Atlas project has allowed the status of the Rose Robin in the Hunter Region to be more closely examined.

METHODS

Two main data sources were utilised: the BLA Atlas and the Hunter Region annual bird report series (Stuart 1994-2016). Atlas data for the Hunter Region were

exported from BLA's main database and supplied to us as an Excel file. These data, which mostly had been collected by well-defined survey methods (Newman *et al.* 2010), were used to generate distribution maps and for statistical analyses as described below. Incidental records for Rose Robin in the Hunter Region from the annual bird reports were reviewed.

A distribution map was generated through analysing the Atlas records within each of 60 bio-geographical sub-areas of the region (Williams & Stuart 2016). The analogous seasonal distribution maps were produced by using only those records obtained between October and March ("breeding distribution") and mid-April to August ("non-breeding distribution").

Reporting Rates (RR) for the region were calculated using a macro developed within the Excel software program (I. Martin unpublished). The regional RR is the ratio of the number of records for Rose Robin obtained from systematic surveys and the total number of systematic surveys conducted in all the 10-minute cells for which there has ever been a record of Rose Robin (Stuart 2016). Incidental records were not included into the calculation.

Timeline graphs were produced after determining the number of Atlas records of Rose Robin for each week of the year and calculating the mean weekly number of records. The analyses were done separately for grouped high and low altitude locations. Time periods were then classified according to whether their mean numbers of weekly records were within 1, 1.5, 2, 2.5 or >2.5 standard deviations from the overall weekly mean (Williams & Stuart 2016).

RESULTS

The general distribution in the region

Figure 1 shows the distribution pattern for Rose Robin based on Atlas data for every month of the year. In total, there were 917 records of Rose Robin in the database (for 1998-2015). 836 records were from systematic surveys and 81 records from incidental searches. Overall, the species has a wide distribution in the region with the stronghold over the whole year being the Barrington Tops. It is usually absent in the far west of the region, except from the Coolah Tops and their foothills. It is also absent from areas within the Hunter Valley floor, and elsewhere, which have been cleared of much of their natural vegetation. However, as will be discussed later, the distribution has a very marked seasonal aspect.

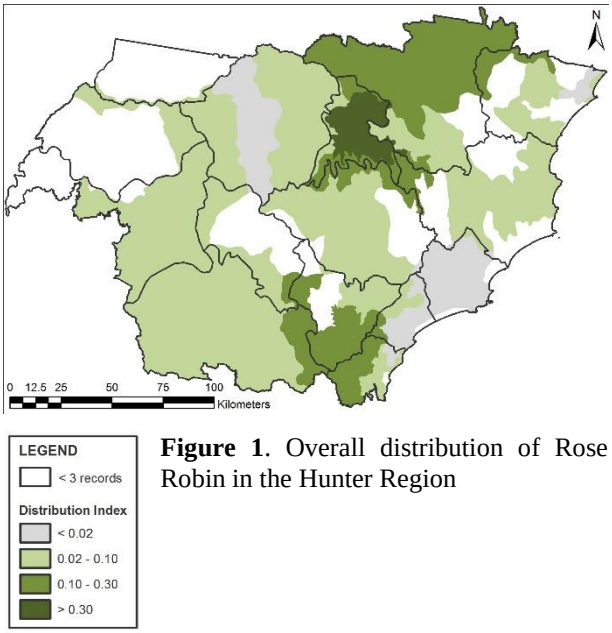


Figure 1. Overall distribution of Rose Robin in the Hunter Region

Reporting Rates

The RR from all the systematic surveys (area and 2ha) in the Hunter Region over the period 1998-2015 was 4.5%. The rate was 2.3 times greater from area surveys (RR 5.3%) than from 2ha surveys (RR 2.3%), as presented in **Table 1**. Each year the ratio of 2ha to area surveys within the Rose Robin's distribution in the Region was found to vary (low of 0.06, high of 0.36). This inconsistency of observer effort complicates attempts at trend analysis. However, because 88% of all the systematic surveys involved area surveys, these became the focus for a detailed analysis for trends.

Table 1. Reporting Rates (RRs) and Standard Deviation (SD) for annual RR from Rose Robin BirdLife Australia Atlas data (1998-2015)

	2ha	Area	Combined
No of records	100	736	836
RR (18-year)	2.3%	5.3%	4.5%
SD (annual RRs)	1.8%	1.8%	1.4%

Figure 2 shows the annual RRs from area surveys. The highest RR was 9.6%, occurring in 2003, while the 2009 RR of 2.0% was the lowest for any year. The standard deviation in the annual RR was 1.8% absolute. Thus, the RR in 2003 is > 2SDs above the long-term annual mean and is statistically significant at a 95% confidence level (Fowler & Cohen 1994).

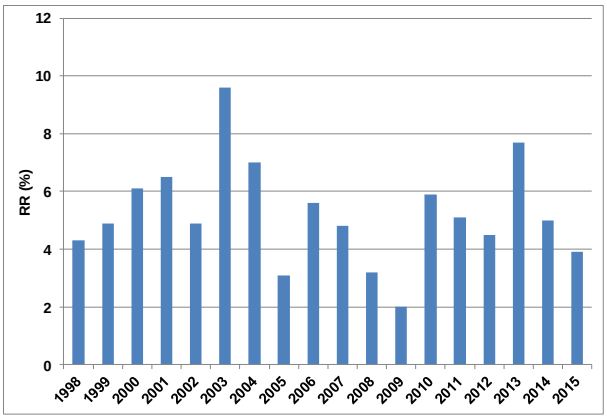
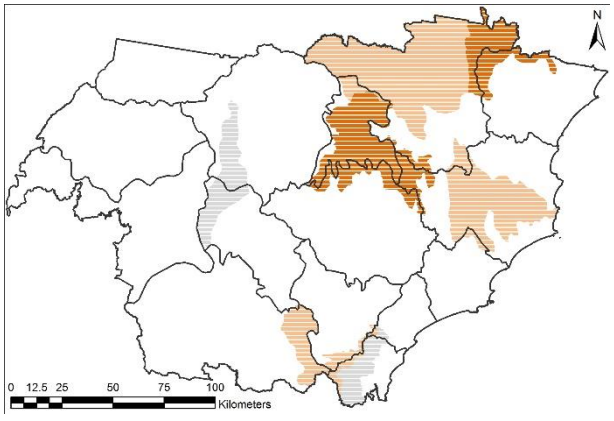


Figure 2. Annual area survey RRs for Rose Robin

Seasonal movements

The Rose Robin is a migratory species, breeding in spring-summer at high altitudes and dispersing in autumn-winter, although the extent to which the migration involves birds moving to lower-lying areas locally (altitudinal migration) or dispersing northwards (latitudinal migration) has been a matter of some debate (Higgins & Peter 2002, Griffioen & Clarke 2002). To investigate the migration for the Hunter Region, summer and winter distribution maps were generated (**Figures 3** and **4**). The summer map (**Figure 3**) confirms the Rose Robin's preference for high altitude sites (Barrington Tops, Watagans, etc) in the breeding season, and then dispersal in autumn-winter (**Figure 4**).



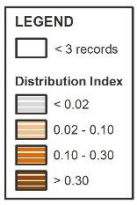


Figure 3. Spring-summer distribution of Rose Robin

To investigate the timing of the seasonal movement, timelines were generated for when birds had been recorded at altitudes above 400m (**Figure 5**) and below 400m (**Figure 6**).

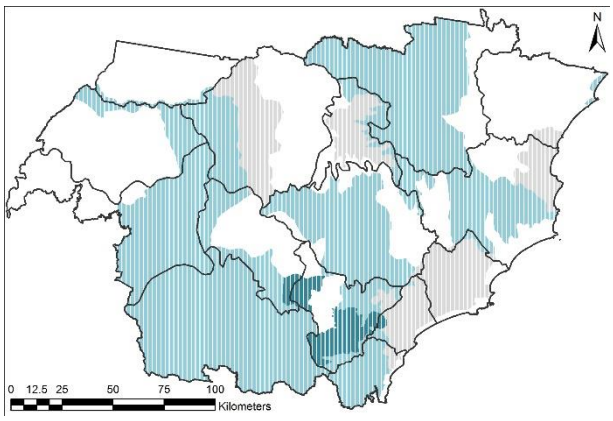


Figure 4. Autumn-winter distribution of Rose Robin

Figure 5. Rose Robin timeline for high altitude records above 400m

Figure 6. Rose Robin timeline for low altitude records below 400m

Most of the records published in the annual bird report series (Stuart 1994-2016) have matched the distribution patterns of **Figures 1**, **3** and **4** and the timelines of **Figures 5** and **6**. Single birds were recorded at Nobbys Beach in March 2013 and Ash Island in September 2010. Both were unusual locations with no other known records at them.

Breeding records

Rose Robins are well-documented as breeding in spring-summer at high altitude (Higgins & Peter 2002). Almost certainly that would also be the case for the Hunter Region. However, there have been surprisingly few breeding records. Birds had dependent young at Woko National Park in September 2012, Allyn River in February 2007 and Gloucester Tops in January 2005, and were reported to be nesting in the Gloucester Tops in December 2007 and October 2004 (Stuart 1994-2016). The only other known breeding record dates from 20 years earlier, when birds were observed to be feeding young at Bretti Reserve near Barrington in November 1984 (HBOC unpublished records).

DISCUSSION

Reporting Rate trends

The long-term trend for Rose Robin RR suggests its status has been maintained (**Figure 2)**. However, over the shorter term there have been some marked fluctuations. The 2003 RR was almost double the long-term average for area surveys, but then followed several years of declining RR, to a nadir of 2.0% in 2009. These fluctuations, which are statistically significant at a 95% confidence level for 2003 (Fowler & Cohen 1994), appear to reflect the prevailing climatic conditions of the time. During 2000-2002, south-eastern Australia experienced a La Niña event, with widespread above-average rainfall (Wikipedia 2016). Possibly those conditions were favourable for Rose Robins (i.e. leading to a population surge after the 2002 breeding season). Then, over 2004-2009, a severe and sustained El Niño-derived drought affected much of Australia, before a more normal rainfall pattern returned in 2010 (Wikipedia 2016). The RRs for Rose Robin were about average in 2004-2007. However, the continuing drought conditions seem eventually to have caused a contraction in numbers in 2008-2009. These were very poor years for the species, with relatively low RRs in both years. Also, birds were recorded in fewer 10-minute grid cells, in particular in 2008 when they were recorded in only nine cells (compared with an annual average of 20 cells across all years excluding 2008-2009).

Seasonal movements

Figure 5, the timeline for records of Rose Robins from above 400m, confirms their annual migration from high altitude locations. The majority of records for birds above 400m occur in spring and summer. By mid-February, some birds have departed and the bulk of them, barring some stragglers, have gone by mid-April. In late August, Rose Robins have begun to return to high altitudes.

Figure 6, the timeline for Rose Robins at sites below 400m, reveals that most of the records have been from the period between late April and mid-August. Records below 400m from mid-November to early January are rare. In other words, they are only occasionally present at lower altitude locations except around winter time.

It seems telling that the two timelines (**Figures 5** and **6**) are close to being mirror images of one another. Griffioen & Clarke (2002) concluded that birds from NSW moved northwards along the eastern coast ("mid East Coast" movement pattern). If that was the case for the Hunter Region, and to fit the behaviour revealed in the timelines, high-altitude birds would need to migrate north in autumn and almost simultaneously be replaced by southern birds migrating into low-altitude locations in the region. The timing coincidence would then require to be reversed in spring. Whilst this might indeed be what is happening, it seems remarkable that the timings of the latitudinal movements would closely coincide in the autumn and spring migrations, producing mirror-image timelines.

Moreover, it should be noted that in spring-summer, Rose Robins in the Hunter Region prefer rainforest habitats whereas in the non-breeding period they occur in woodlands. It seems unlikely that migrating Rose Robins would reject suitable lower altitude woodlands nearby to their spring-summer territories and opt instead to make a longer distance latitudinal migration to find the same sort of habitat elsewhere.

Overall, it is simpler to explain Rose Robin movements in the region as being predominantly an altitudinal migration rather than a latitudinal one. However, the records from Nobbys Beach in 2013 and Ash Island in 2010 may have involved birds on latitudinal migration passage using the "mid East Coast" movement (Griffioen & Clarke 2002). In other words, there may be elements of both migration patterns occurring in the Region.

Breeding records

Although there have not been many breeding records, they all have originated from mid to high altitude locations within the region. This confirms the pattern noted elsewhere within the Rose Robin's range (Higgins & Peter 2002).

CONCLUSIONS

The Rose Robin is a relatively common species within the Hunter Region, with a widespread distribution and an average reporting rate of 4.5% in the BirdLife Australia Atlas project. It has exhibited susceptibility to climate extremes, with the local population increasing significantly in times of above average rainfall and decreasing substantially during extended droughts. Because climate extremes are expected to become more pronounced in future, it will be important to continue to monitor the local status of the Rose Robin.

Birds are mainly found at high altitude locations in spring-summer, where they breed. They appear to mainly disperse in autumn-winter to lower altitude woodlands within the region.

ACKNOWLEDGEMENTS

We thank BirdLife Australia for providing records from the Atlas database and in particular, the strong support we have received from Andrew Silcocks, the BLA Atlas project manager. BLA has data exchange arrangements with other organisations including the New South Wales Bird Atlassers and the use of the latter's Hunter Region records from 1998-2001 is acknowledged.

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Black-eared Cuckoo; mimicry of host's juvenile plumage facilitates parasitism of Speckled Warblers

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Speckled Warblers *Pyrrholaemus sagittatus* were observed feeding a fledged juvenile Black-eared Cuckoo *Chalcites osculans* at Green Wattle Creek, near Paterson in NSW in 1994. The Black-eared Cuckoos had successfully parasitised at least three Speckled Warbler pairs. Records of Black-eared Cuckoos in the Paterson area and near-coastal areas of NSW are rare and breeding unprecedented.

Recent advances in understanding of evolutionary adaptations of cuckoos and their hosts and their interactions have provided an improved understanding of the significance of these observations made over 20 years ago. Imitation of the plumage of their hosts' juveniles is pivotal to breeding success of Australian bronze-cuckoos (*Chalcites* species). Black-eared Cuckoos have evolved a white tail tip, which mimics the plumage of their primary hosts, Speckled Warbler and Redthroat *Pyrrholaemus brunneus*, in both juvenile and adult plumage. The high success rate of the Black-eared Cuckoo in successfully deceiving multiple pairs of Speckled Warblers is attributed to the naivety of the Green Wattle Creek Speckled Warbler population, which do not normally experience the presence of Black-eared Cuckoos.

INTRODUCTION

There is considerable variation in the breeding strategies used by cuckoos. At one extreme species like the Pheasant Coucal *Centropus phasianinus* are not brood parasites, building nests, incubating eggs and raising their own young. At the other extreme many cuckoo species rely on a host species to incubate cuckoo eggs in their nests, and feed the hatched cuckoo until it is independent. Many species of migratory cuckoos depart before their juveniles are independent. The Common Cuckoo *Cuculus canorus*, which has been extensively studied in Europe, is an example (Davies 2015). As discussed below other cuckoo species, including the Australian bronze-cuckoos (*Chalcites* species), are more sophisticated brood parasites than the Common Cuckoo. Recent advances in the understanding of the interactions between parasitic cuckoos and their hosts have explained observations I made over 20 years ago on Speckled Warblers *Pyrrholaemus sagittatus* acting as brood hosts of the Black-eared Cuckoo *Chalcites osculans*, a member of the genus *Chalcites*.

OBSERVATIONS

On 29 September 1994 I observed a Speckled Warbler feeding a fledged juvenile cuckoo in dry woodland at Green Wattle Creek (32° 40' S, 151° 39' E), near Paterson NSW. Aware that the Speckled Warbler was a known primary host of the Black-eared Cuckoo, which is a rare species in the Hunter Region, I returned to the area periodically to follow breeding progress. On 15 October I saw a juvenile Horsfield's Bronze-Cuckoo *Chalcites basalis* being fed by a Superb Fairy-wren *Malurus cyaneus*. My initial reaction was that the juvenile cuckoo seen on the previous occasion was successfully soliciting food from a range of species and might have been misidentified when initially seen in September. However, I subsequently detected Speckled Warblers feeding another juvenile cuckoo nearby, and this cuckoo had a white-tail tip, which is diagnostic of Black-eared Cuckoos, a plumage feature also apparent in adult birds. During this and subsequent visits I found a total of three pairs of Speckled Warbler, which I am confident were different pairs, feeding juvenile Black-eared Cuckoos. I did not see or hear an adult Black-eared Cuckoo on any occasion.

These are the only records of Black-eared Cuckoos at Green Wattle Creek between 1993 and 2014, during which period I monitored the bird population at least monthly. Speckled Warblers were abundant at that time, but declined in subsequent years (Newman 2010 & 2014) following changes in land management involving the removal of cattle.

1994 was an exceptional year. The Hunter Region and most of eastern Australia was subject to severe drought throughout much of the year. The entire Hunter Region was affected, particularly the central and western areas (Stuart 1994).

When these observations were made I was aware of the unusual nature of this record and took field notes, which formed the basis of an unusual record report form, submitted to and accepted by the Hunter Bird Observers Club. This was a prerequisite for publication of the record in their annual bird report (Stuart 1994).

DISCUSSION

It is well known that brood hosts are tricked into rearing young cuckoos. Davies (2015) in his recent book provides an overview of studies into the interaction between *cuckoos* and their hosts. These studies have demonstrated the strategic battle between parasite and host resulting in an "arms race" in which both cuckoo and host species evolve improved trickery of hosts (by cuckoos) and defences against cuckoos (by hosts) to ensure the survival of their species.

Davies suggests that the Common Cuckoo is a relatively unsophisticated brood parasite. Brood hosts of the Common Cuckoo in the UK include the Reed Warbler *Acrocephalus scirpaceus*, Meadow Pipit *Anthus pratensis*, Redstart *Phoenicurus phoenicurus* and Dunnock *Prunella modularis*. Imitating the size and colour of the host's egg is a key feature of the Common Cuckoo's strategy to deceive the host species. The female cuckoo surreptitiously replaces one of the host's eggs before the clutch is complete. Different races of the Common Cuckoo specialise in parasitising different species and produce eggs which are the same colour as the host species (i.e. brown for Reed Warbler, green for Meadow Pipit and blue for Redstart). However, the race of Common Cuckoos parasitising Dunnocks successfully deceives their host without imitating the blue colour of the host's egg. Davies suggests that this is because the Dunnock is a relatively recent host of the Common Cuckoo and has yet to develop the ability to detect and reject cuckoo eggs, even if these are a poor imitation. In the future it is anticipated that Dunnocks will detect and reject cuckoo eggs and cuckoos parasitising Dunnocks will develop blue eggs, similar to those used to deceive Redstarts.

Davies (2015) suggests that the Australian bronze-cuckoos have developed tricks to deceive their hosts, which are more sophisticated than those employed by the Common Cuckoo in Europe. Speckled Warbler and Redthroat *Pyrrholaemus brunneus* are regular hosts of Black-eared Cuckoo, but breeding behaviour of these cuckoo-host combinations has not been extensively studied (Higgins 1999). Reports of parasitism of fairy-wrens by Black-eared Cuckoos are rare (Booker & Booker 1989). Comprehensive studies of other bronze-cuckoo species provide insights into the sophistication of interactions between cuckoo and host which are potentially relevant to the Black-eared Cuckoo. Langmore & Kilner (2010) found that Superb-Fairy Wrens did not reject eggs of Horsfield's Bronze-Cuckoo and their primary defence was to detect and reject newly hatched cuckoo chicks. Horsfield's Bronze-Cuckoo hatchlings mitigated the chance of detection by having similar pinkish skin colour and begging calls to juvenile Superb Fairy-wrens. Apparently, despite these measures, female Superb Fairy-wrens frequently detect Horsfield's Bronze-Cuckoo hatchlings and abandon their nests, although males may continue to feed the cuckoo for a day or two. In contrast, Shining Bronze-Cuckoo *Chalcites lucidus* and Little Bronze-Cuckoo *Chalcites minutillus* hatchlings have yellow and black skin, imitating the colour of their primary hosts, which are Thornbill *Acanthiza* and Gerygone *Gerygone* species respectively. To explain why Australian bronze-cuckoo hatchlings are rejected, but Common Cuckoo hatchlings are not, Davies (2015) suggests that the "arms race" in Australia is more ancient than in Europe and there has been more time to evolve sophisticated counter strategies. This proposition is consistent with DNA evidence, which suggests that Australian bronze-cuckoos have been interacting with their hosts for several million years, compared with 80,000 years for the Common Cuckoo.

Langmore & Kilner (2010) have summarised the hierarchy of host defences against cuckoos, which include cuckoo recognition and mobbing, egg rejection and chick rejection. Successful cuckoos evolve counter measures to avoid detection at each of these stages. For instance, although the male bird's calls are likely to attract attention, many species have evolved in such a way as to present a falcon-like silhouette likely to discourage mobbing. Cuckoos, especially the female, are very secretive near nests to avoid detection by host species. I did not record any adult Black-eared Cuckoos at Green Wattle Creek, which is

consistent with their adopting furtive behaviour to avoid detection by hosts.

The Black-eared Cuckoo and other bronze-cuckoo species parasitise hosts which build domed nests. Langmore (2013) has suggested that the dark interior of enclosed nests makes it difficult for host species to detect visual differences in eggs, provided that they are of a similar size. Dark egg colouration is an advantage favouring the cuckoo. Black-eared Cuckoo eggs fit this criterion. They are very similar to those of the main hosts, Redthroat and Speckled Warbler, being variously described as reddish-chocolate and chocolate-brown. Interestingly this colour is not incorporated into the egg shell and can be rubbed off with a damp finger, leaving a pale blue shell beneath (Higgins 1999).

Consequently, the most important line of deception employed by bronze-cuckoos lies in chick mimicry, involving hatchlings which visually resemble and sound like those of host species (Langmore 2013). Conversely, the primary defence of the hosts of bronze-cuckoos is to be able to detect chick mimicry. In the case of the Black-eared Cuckoo my observations indicate that the mimicry extends to the evolution of a white tip to the tail, a characteristic of both primary host species, Speckled Warbler and Redthroat. This feature is missing from the juveniles of the other bronze-cuckoo species, which allowed me to differentiate between the fledged young of Horsfield's Bronze-Cuckoo and Black-eared Cuckoo breeding in close proximity at Green Wattle Creek. Recognition and rejection of cuckoo hatchlings has been shown to be learned behaviour with successful parasitisation higher in Superb Fairy-wren populations not previously exploited by cuckoos, compared with those previously parasitised (Langmore *et al*. 2012).

Successful brood parasites must not only have effective strategies for cheating on their hosts, but also avoid competition with other cuckoos. Territorial behaviour minimises the risk of multiple eggs of the same cuckoo species being deposited in a host nest, or even a cuckoo's egg being substituted by the egg of a second cuckoo female. In the present instance involving an out of range presumed single pair of Black-eared Cuckoos breeding at Green Wattle Creek, intra-species competition was not a difficulty, but inter-species competition was a possibility. At Green Wattle Creek four other cuckoo species occur, which predominantly exploit domed nests. Langmore (2013) provides insights into strategies, which minimise competition between these species by using different hosts. In the case of the competing cuckoo species at Green Wattle Creek: Horsfield's Bronze-Cuckoos primarily select Fairy-wren hosts, while the Shining Bronze-Cuckoo usually parasitises thornbill species and Fan-tailed Cuckoos *Cacomantis flabelliformis* and Brush Cuckoos *Cacomantis variolosus* also favour host species which build domed nests, mainly thornbills and scrub-wrens (Higgins 1999). Hence although Speckled Warblers have been known to host Fan-tailed Cuckoos (Higgins 1999), they are not normally parasitised by any of these cuckoo species.

The very high success rate with which the Black-eared Cuckoo parasitised Speckled Warblers at Green Wattle Creek warrants comment. In October 1994 I recollect thinking that every Speckled Warbler found seemed to be feeding a juvenile Black-eared Cuckoo. As mentioned previously Langmore *et al.* (2012) have suggested that cuckoos are more successful when dealing with naïve hosts, and that they may strategically change their territories between years to avoid decreased breeding success associated with experienced hosts. The Speckled Warbler population at Green Wattle Creek would fall in the naïve category with respect to Black-eared Cuckoos, which are extremely rare in the Paterson area.

CONCLUSIONS

When these observations were first made over twenty years ago, I used the white tip to the tail of recently fledged cuckoos as a diagnostic identification tool. I appreciated the fact that this plumage feature involved mimicry of the Black-eared Cuckoo's two primary hosts, Speckled Warbler and Redthroat. It was also apparent that this adaptation to mimic the appearance of their host's juveniles had resulted in the evolution of Black-eared Cuckoos with an adult plumage characteristic, namely the white tip to the tail, which is characteristic of their adult hosts and not present in the other species of Australian bronze-cuckoo.

Since my observations in 1994 there have been significant advances in understanding the behavioural adaptations and interactions between cuckoos and their hosts, both overseas (Davies 2015) and in Australia (Langmore 2010 & 2013). Davies has suggested the possibility that the Australian bronze-cuckoos occurred early in evolutionary history and as a consequence the

"arms race" between host and parasite is more advanced than in the Common Cuckoo of Europe. As a consequence bronze-cuckoos have evolved sophisticated adaptations to prevent their hosts from detecting and rejecting hatched cuckoos. Langmore *et al.* have demonstrated that learning by experience is important with respect to detection of cuckoos and preventing parasitism. Also the hosts of bronze-cuckoos may be forced to rely on the detection of hatched cuckoos, because of the difficulty of detecting and rejecting cuckoo eggs in the darkness of their domed nest structures. These developments provide a more complete understanding of my 1994 observations of arguably the least studied of the bronze-cuckoos. The Black-eared Cuckoo may well be the most sophisticated mimic of the genus, having adapted to imitate a feature of its host's juvenile and adult plumage, namely the white tail tip.

The fact that a number of pairs of Speckled Warblers were successfully parasitised by the Black-eared Cuckoos at Green Wattle Creek is attributed to the fact that Black-eared Cuckoos seldom occur as far east in NSW as the Paterson area. This unusual occurrence at Green Wattle Creek was probably a consequence of drought conditions, which were prevalent inland at that time.

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Birdlife at Belmont Lagoon: past and present

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Belmont Lagoon is a coastal wetland adjacent to Lake Macquarie near Belmont NSW. Little is documented about the birdlife it supports. This paper describes a recent study which identified 113 bird species in a 14-month period. It summarises these data and compares them with an earlier report listing 66 species at the same lagoon. Differences between these bird lists, together with recent observations of habitat flora and hydrological evidence, suggest ecological changes to the Lagoon may have influenced migration of some wetland species to other local sites. Comparative data from coastal wetlands in the Hunter Region may assist our understanding of how the Lagoon conserves avifauna in this area.

INTRODUCTION

Belmont Lagoon (33^{0}02'39"S, 151^{0}39'48"E) is located between the Pacific Ocean and Lake Macquarie in the community of Belmont, NSW (see **Figure 1**). It has a rich indigenous cultural heritage for the *Awabakal* people, and its surrounding landscape also has an interesting war-time legacy. Nearby coastal scrubland, and Cold Tea Creek adjacent to the lagoon, were modified c.1942 as part of the region's defence against possible Japanese invasion. The Department of Defence dredged Cold Tea Creek to provide an anti-tank barrier, dividing the lagoon into two parts:
(http://www.visitlakemac.com.au/belmont/belmont-lagoon-reserve).

The Lagoon is a major wetland located on aeolian sand with a restricted connection to Lake Macquarie via Cold Tea Creek. Shortland Wetlands Centre (1989) described it as *estuarine/palustrine* with several local saline/brackish wetlands contributing to it after heavy rainfall. The landscape is dominated by Swamp She-oak *Casuarina glauca*, Broad-leaf Paperbark *Melaleuca quinquenervia* and Coast Banksia *Banksia integrifolia* plus wet heath species Crimson Bottlebrush *Callistemon citrinus*, and Swamp Paperbark *Melaleuca ericifolia*. It has quite a large surface area (approx. 40ha) and a shallow depth (10cm-1m). Despite being located between lake and sea the Lagoon is indirectly connected to the Lake via four concrete pipes (3m long x 60cm diam.), allowing water to flow into or from Cold Tea Creek. The Lagoon's salinity in 1989 was reportedly lower than the Lake, but Brown (2003) has since provided revised data on the hydrology and ecology of the Lagoon – indicating that while the Lagoon may have originally been brackish, it is now saltwater. Increases in the Lagoon's salinity, and warmer temperature in summer support abundant new growth (saltwater plants, fish-fry) providing seasonal nutrition for many wetland species.

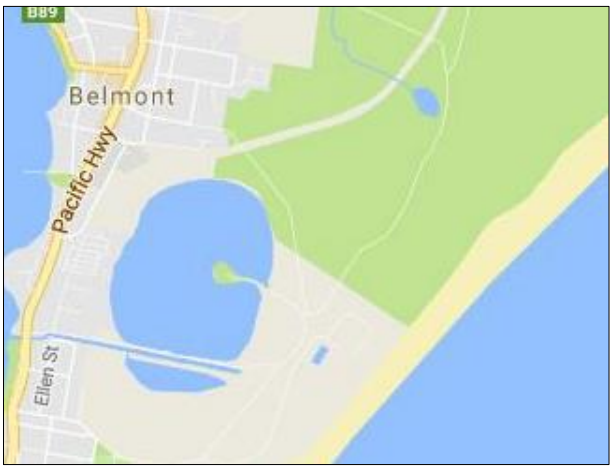

Figure 1: Map of Belmont Lagoon

Figure 1 shows Belmont Lagoon divided in two parts by Cold Tea Creek. Surveys were conducted around the larger northern part of the lagoon. The smaller southern part is subject to tidal flow, and is much shallower and more protected from adverse weather than the northern part. Its mudflats seem to attract several larger wetland bird species but it is difficult for observers to access and its mangrove trees restrict observation. The southern margin is

extensively overgrown with Broad-leaved Cumbungi (*Typha orientalis*).

The Lagoon attracts many wetland and woodland bird species but their identity and use of this habitat is not well documented. This paper draws on several data sources to improve our understanding. The first is a summary of surveys completed at the Lagoon from April 2015 to May 2016. The second is a list of birds reportedly observed here from 1968-73 (Holmes 1973), which includes species not seen here during recent surveys. The aim of this paper is not only to increase awareness of the Lagoon's ecological nature but also to assist conservation by encouraging the observation and reporting of wetland species in this area.

METHODS

Current Study

From 6 April 2015 to 30 May 2016 the author conducted a total of 37 surveys (typically 3/month). Each survey followed the same trail, recording bird species seen on a standard 3-4km walk around the northern part of the Lagoon and its surrounds, beginning (and ending) at the western end of Cold Tea Creek. Each survey took approximately 90 minutes and was completed between 6:00 and 10:00am. All calling species detected were tape-recorded; birds identified on these recordings were later noted down, and the results were tallied and transferred to an Excel data file for statistical analyses involving maximum and mean counts as well as reporting rates.

Comparison of this survey data with the birds recorded by Holmes (1973) is used to highlight changes in bird diversity over time.

RESULTS

In total 113 species were recorded in the 14-month observation period: 34 wetland species and 79 others. This paper focuses on wetland birds (including three raptors and three passerines) which are listed in **Table 1**, in decreasing order of Reporting Rate (RR). The Reporting Rate is the percentage of surveys a species has been reported relative to the total number of surveys (37) completed. A relatively large number of both wetland species and other species with RR>40 was observed throughout the year, suggesting that many species are resident or visit the Lagoon and its surrounds regularly.

Table 1 – Wetland species recorded at Belmont Lagoon between April 2015 and May 2016

Common Name	Scientific Name	Maximum	Mean	RR (%)
Black Swan	*Cygnus atratus*	256	59.3	97.3
Silver Gull	*Chroicocephalus novaehollandiae*	204	28.3	94.6
Little Pied Cormorant	*Microcarbo melanoleucos*	28	6.3	91.9
Little Black Cormorant	*Phalacrocorax sulcirostris*	83	16.0	91.9
Chestnut Teal*	*Anas castanea*	40	14.6	86.5
Great Egret	*Ardea alba*	16	4.8	83.8
Australian Pelican	*Pelecanus conspicillatus*	71	16.0	81.1
Grey Teal*	*Anas gracilis*	32	9.3	67.6
Australian Wood Duck*	*Chenonetta jubata*	26	5.9	62.2
White-faced Heron	*Egretta novaehollandiae*	11	2.4	59.5
Masked Lapwing	*Vanellus miles*	8	3.0	56.8
Pacific Black Duck	*Anas superciliosa*	7	2.8	54.1
Little Egret	*Egretta garzetta*	15	4.3	51.4
Intermediate Egret*	*Ardea intermedia*	13	4.2	37.8
Great Cormorant	*Phalacrocorax carbo*	4	1.8	32.4
Australian White Ibis*	*Threskiornis moluccus*	5	2.2	29.7
Crested Tern	*Thalasseus bergii*	3	1.7	27.0
Striated Heron*	*Butorides striata*	3	1.3	24.3

Table 1 – Wetland species recorded at Belmont Lagoon between April 2015 and May 2016 cont.

Common Name	Scientific Name	Maximum	Mean	RR (%)
Black-winged Stilt*	*Himantopus leucocephalus*	15	6.2	24.3
Striated Heron*	*Butorides striata*	3	1.3	24.3
Black-winged Stilt*	*Himantopus leucocephalus*	15	6.2	24.3
White-bellied Sea-Eagle*	*Haliaeetus leucogaster*	2	1.3	16.2
Australasian Grebe	*Tachybaptus novaehollandiae*	2	1.5	10.8
Pied Cormorant*	*Phalacrocorax varius*	6	2.8	10.8
Caspian Tern	*Hydroprogne caspia*	3	1.5	10.8
Osprey*	*Pandion haliaetus*	1	1.0	8.1
Swamp Harrier*	*Circus approximans*	1	1.0	8.1
Tawny Grassbird	*Cinclorhamphus timoriensis*	1	1.0	8.1
Straw-necked Ibis*	*Threskiornis spinicollis*	10	5.5	5.4
Mangrove Gerygone	*Gerygone levigaster*	1	1.0	5.4
Australasian Darter*	*Anhinga novaehollandiae*	1	1.0	2.7
Aust. Pied Oystercatcher*	*Haematopus longirostris*	1	1.0	2.7
Red-necked Avocet*	*Recurvirostra novaehollandiae*	1	1.0	2.7
Australian Reed-Warbler	*Acrocephalus australis*	1	1.0	2.7

Note: *Species not recorded by Holmes (1973)

Species recorded and frequency

Twenty species were recorded with RR of 80 or more; seven wetland, and 13 other species. However, this criterion can underestimate species' dependence on the lagoon. Some wetland species (with RR as low as 30) move between Lake and Lagoon due to tidal or other factors, and may not be recorded. In high tide and strong winds, some wetland species (Intermediate Egret *Ardea intermedia*, Australian White Ibis *Threskiornis moluccus*) vacated the Lagoon but were later noticed nearby. Sixty-three species have been recorded with a RR between 10 and 80, including 18 wetland species and 45 other species. Thirty species were occasionally present, with RR<10 (i.e. observed on less than 10% of surveys). Of the 24 other species, 13 were observed once only at Belmont Lagoon. There are nine wetland species in this group. Among these Swamp Harrier *Circus approximans* and Osprey *Pandion haliaetus* were observed perched or hawking over the Lagoon or Cold Tea Creek. Australian Pied Oystercatcher *Haematopus longirostris*, Red-necked Avocet *Recurvirostra novaehollandiae* and Black-winged Stilt *Himantopus leucocephalus* were observed actively feeding in small groups, mid-lagoon in mid-summer.

It is notable that a total of nine raptor species were recorded at Belmont Lagoon during recent surveys, including six listed in **Table 2** that are not here treated as wetland species.

Table 2 – Additional raptor species recorded at Belmont Lagoon.

Common Name	*Scientific Name*	Maximum	Mean	RR (%)
Grey Goshawk**	*Accipiter novaehollandiae*	1	1.0	16.2
Brown Goshawk**	*Accipiter fasciatus*	2	1.2	13.5
Black-shouldered Kite	*Elanus axillaris*	1	1.0	10.8
Black Kite**	*Milvus migrans*	1	1.0	2.7
Collared Sparrowhawk**	*Accipiter cirrocephalus*	1	1.0	2.7
Nankeen Kestrel**	*Falco cenchroides*	1	1.0	2.7

Note: **Species not recorded by Holmes (1973)

Most other species that were recorded, including the regionally uncommon Brush Bronzewing *Phaps elegans*, were among those recorded in surveys of the Belmont Wetlands (an area partially visible in **Figure 1**, NE of Belmont Lagoon); this will be the subject of a subsequent paper. Non-wetland species that were not recorded at Belmont Wetlands include Blue-faced Honeyeater (RR 10.8), Fork-tailed Swift (5.4), Southern Emu-wren *Stipiturus malachurus* (5.4), White-winged Triller *Lalage tricolor* (2.7), White-browed Woodswallow *Artamus superciliosus* (2.7), and Black-faced Monarch *Monarcha melanopsis* (2.7). A full species list will be available on the HBOC website: http://www.hboc.org.au/publications/the-whistler/

Behavioural observations

During the surveys reported numerous memorable observations were made that reflect the ecological diversity of the wetland and its importance as a recreational asset readily accessible to the community. Little Egret, Great Egret, White-faced Heron, Little Black Cormorant, Australian Pelican and Silver Gull feeding collaboratively in shallows near mangroves on the eastern side. Egrets spring in the air, wings outstretched, herding fish-fry towards the water's edge where they are 'picked off' by others present. A pair of Chestnut Teal guide their 10 ducklings towards shelter on a brackish channel beside the lagoon as a Swamp Harrier attempts to capture one. On a calm morning in summer up to 256 Black Swan are grazing on water-weed. Australian Pied Oystercatcher, Black-winged Stilt and Red-necked Avocet search for molluscs or crustaceans at low-tide. Meanwhile a pair of White-bellied Sea-Eagles are perched like sentinels on a power-pole beside Cold Tea Creek in May. Perhaps the rarest of all observations was 30 or more Fork-tailed Swift *Apus pacificus* 'dipping' their wings in the Lagoon early one morning in December, seen from 100 metres away.

Holmes' report (1973)

In 1973, Glenn Holmes, a former member of the *Hunter Natural History Group*, published a report titled *Birds of Belmont Lagoon*. The report lists 66 species observed from 1968-73, and is based on casual observations at the Lagoon, immediately adjacent reeds, marsh and swamp forest.

It is, as Holmes admitted, "by no means a comprehensive account of the species present". For example, he provides only a short list of woodland bird species – presumably because of his stated focus. However, his data may indicate several key differences between the wetland birds using the Lagoon today compared with 42 years ago.

One difference is the current absence of certain species (e.g. Dusky Moorhen *Gallinula tenebrosa*, Purple Swamphen *Porphyrio porphyrio*, Eurasian Coot *Fulica atra*, Buff-banded Rail *Hypotaenidia philippensis* and Black-fronted Dotterel *Elseyornis melanops*) recorded by Holmes (1973). These species mostly prefer habitats with freshwater weed and molluscs, which is consistent with the suggestion that their foraging habitat (i.e. the Lagoon itself) has become more saline over the years.

A second notable difference is the current absence of migratory shorebirds at the Lagoon. Holmes recorded, for example: Common Greenshank *Tringa nebularia*, Red Knot *Calidris canutus*, Great Knot *Calidris tenuirostris*, Sharp-tailed Sandpiper *Calidris acuminata*, Pectoral Sandpiper *Calidris melanotos*, Curlew Sandpiper *Calidris ferruginea* and Bar-tailed Godwit *Limosa lapponica*. He also noted Marsh Tern (Whiskered Tern) *Chlidonias hybrida* and Little Tern *Sternula albifrons*. Various explanations are possible. One is that some of these species may still visit the Lagoon in season, but these have not been recorded (by GF) to date. Perhaps these species still visit the south-eastern side of the Lagoon (as mentioned by Holmes). However, much of this area is difficult to observe at present due to mangroves. Another explanation is that significant declines in the populations of migratory shorebirds on the East Asian-Australasian Flyway since the 1970s (Clemens *et al*. 2016) have led to the absence of shorebirds at sites formerly used by relatively few birds.

A third and important difference, indicating the continuing ecological health of Belmont Lagoon, is the total of 15 wetland species currently observed there which were *not* reported by Holmes (see species with asterisk in **Table 1**).

A fourth difference is that, in the surveys then conducted by Holmes, only two species of raptor were recorded visiting the lagoon.

CONCLUSIONS

113 species were observed at Belmont Lagoon within 14 months; 34 were considered wetland species. The Lagoon attracts not only a healthy number of wetland species, but also sizeable flocks (e.g. at least eight species were recorded with over 20 birds on a survey). Some species are known as seasonal migrants (Stuart 2014).

The numbers appear comparable with those observed by Stuart (2015) at another coastal wetland. He identified 123 species, including 27 that are dependent on water, from surveys over a five-year period at Saltwater National Park (SNP) in the Manning Valley. His list includes 68 species in common with the present list for Belmont Lagoon, only 15 of which were wetland species.

Informed opinion and current data support the view that some wetland species recorded 40 years ago might still appear in season at the Lagoon. Three strategies may help achieve this:

- targeted observations in areas of the Lagoon where such species can most be expected;
- greater awareness of the optimal habitat and conditions under which migratory shorebirds and others roost or feed at similar sites;
- a realistic assessment (and effective management) of the habitat that would promote their return to the Lagoon or adjacent marshes.

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Threatened bird species in the Hunter Region: 2016 status review

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Eighty-nine species or sub-species which have been recorded within the Hunter Region are classified as threatened under at least one of three relevant conservation classification schemes – the *Threatened Species Conservation Act 1995* of NSW, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the International Union for Conservation of Nature (IUCN) review. The majority of them are also classified as threatened in the Action Plan for Australia's Birds. The ratings for these 89 threatened species or sub-species under all four conservation classification schemes have been collated and recent local trends have been summarised.

Many threatened species are no longer recorded locally in the numbers that historically were considered typical. For most, the main declines occurred one or more decades ago and their local status has not changed so much in recent times. However, the prospects for nine species have warranted discussion. They are: Gould's Petrel *Pterodroma leucoptera*; Eastern Curlew *Numenius madagascariensis*; Bar-tailed Godwit *Limosa lapponica*; Black-tailed Godwit *Limosa limosa*; Red Knot *Calidris canutus*; Swift Parrot *Lathamus discolor*; Rufous Scrub-bird *Atrichornis rufescens*; Regent Honeyeater *Anthochaera phrygia* and Hooded Robin *Melanodryas cucullata*.

INTRODUCTION

Roderick & Stuart (2010) discussed 74 species and sub-species occurring in the Hunter Region that had been listed as threatened under the *Threatened Species Conservation* (TSC) *Act 1995* of New South Wales. The TSC Act is the primary legislation for the protection of threatened flora and fauna species in NSW. The *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* is the equivalent threatened species legislation at the Commonwealth level. It is applicable for many Hunter Region species. Another measure of conservation status was developed by the International Union for Conservation of Nature (IUCN 2009). It can be applied at sub-species level as well as species level. Some species and sub-species that occur in the Region have IUCN conservation ratings.

The 2010 list of threatened species (Roderick & Stuart 2010) focussed on TSC Act species, also noting whenever there were any EPBC or IUCN classifications for them. Since 2010, changes have occurred for a variety of reasons:

- some additional Hunter Region species have been listed under the TSC Act and/or the EPBC Act;
- some species, which already were listed, have been reclassified into a different threatened species category; and
- some threatened seabird subspecies have been elevated to full species level.

The nomenclature and taxonomy used in this paper follows BirdLife Australia Working List V2 (BirdLife Australia 2015). There now are 89 Hunter Region species and sub-species listed as threatened under the TSC and/or EPBC Acts, or under an IUCN classification. The prime objectives for this paper were to collate the conservation status for those species and subspecies and, for each, to review what changes may have occurred since the previous paper (Roderick & Stuart 2010). Nine species whose prospects were considered to have deteriorated have been discussed in more detail.

The Action Plan for Australian Birds (APAB) (Garnett *et al.* 2011) also assigned a conservation status to many species and sub-species which occur in the Hunter Region. For local species with TSC, EPBC or IUCN ratings, their APAB classifications are also presented in this paper. A complete set of all the APAB listed species has not been included, for space reasons (and overlap, in many instances).

Threatened Species Classifications

The three classification schemes, TSC, EPBC and IUCN, can broadly be considered to reflect state, national and international perspectives, respectively. All use an escalating set of terms to describe threatened species: Vulnerable (V), Endangered (E), Critically Endangered (CE) or Presumed Extinct (PE). The IUCN also uses Near Threatened (NT) for species they consider are at risk of becoming threatened, and Least Concern (LC) for species not considered threatened. In certain circumstances, these classifications may be applied to a sub-species or to a local population.

The key threats vary across the various bird guilds: waterbirds, migratory shorebirds, beach-nesting birds, rainforest birds, nocturnal birds, woodland birds, birds of prey. Roderick & Stuart (2010) provide a summary of them, and describe the unique threats which are applicable for certain species.

Acronyms/Abbreviations

APAB: Action Plan for Australia's Birds
BLA: BirdLife Australia
CTI: Cabbage Tree Island
CE: Critically Endangered
E: Endangered
EP: Endangered Population
EPBC Act: *Environment Protection and Biodiversity Conservation Act 1999*
HBOC: Hunter Bird Observers Club Inc.
HEZ: Hunter Economic Zone
IBA: Important Bird & Biodiversity Area
IUCN: International Union for Conservation of Nature
LC: Least Concern
NP: National Park
NR: Nature Reserve
NSW: New South Wales
NT: Near Threatened
SP: State Park
TSC Act: *Threatened Species Conservation Act 1995* (NSW)
V: Vulnerable

METHODS

The paper is focussed on capturing changes in status for threatened Hunter Region bird species since 2010 (Roderick & Stuart 2010). The information presented then is not re-presented here, other than *inter alia* when the status changes for some species are discussed.

The geographical extent of the Hunter Region has been defined in each year's Bird Report (Stuart 2011-2016) and in several publications, for example, Newman *et al.* (2010). Also, a Google Earth shapefile for the Region is available at http://www.hboc.org.au/resources/hunter-region/.

A major information source was HBOC data from the Annual Bird Reports for the Hunter Region spanning the years 2010-2015 (Stuart 2011-2016). This information was supplemented by other published articles (as referenced herein), data in the BLA Atlas database (which is made available to HBOC as an annual update) and observations made by either of the two authors during their field work.

Although databases managed by other organisations contain additional records for the Hunter Region, these were not used. Whilst they may have allowed further insights, there were two important difficulties. In some cases, access to the database was not readily available and in other cases the vetting process for records was considered to have been less rigorous than desirable. All HBOC records are subjected to scrutiny by a Records Appraisal Committee, comprising seven experienced local observers, before they are accepted into the Club's database.

DISCUSSION

Hunter Region Threatened Species

The main changes which have occurred since Roderick & Stuart (2010) are summarised in **Table 1**. One species (Hooded Plover *Thinornis cucullatus*) is a very recent addition to the Hunter Region checklist. Twenty other species have been newly listed under the TSC or EPBC Acts, or have had their pre-2010 classifications changed. **Table 1** includes three former sub-species of albatross which are now treated as full species under current BLA taxonomy.

There now are 89 species occurring in the Hunter Region which are classified as threatened under the TSC and/or EPBC Acts, or the IUCN ratings. Also, one species, the Antipodean Albatross *Diomedea antipodensis*, has two threatened sub-species; the nominate Antipodean Albatross *D.a. antipodensis* and Gibson's Albatross *D.a. gibsoni*. **Table 2** summarises TSC, EPBC and IUCN classifications for all the Hunter Region species and sub-species.

In mid-2016, the NSW Scientific Committee made a Preliminary Determination to list the White-bellied Sea-Eagle *Haliaeetus leucogaster* as Vulnerable. As the Committee's decision had not been finalised at the time of writing, comments about this species have not been included.

Table 1. Changes in conservation classification under the EPBC Act and/or TSC Act since 2010.

Species	**Change(s)**
Lesser Sand Plover *Charadrius mongolus*	Newly listed in 2016 as Endangered under the EPBC Act.
Greater Sand Plover *Charadrius leschenaultii*	Newly listed in 2016 as Vulnerable under the EPBC Act.
Hooded Plover *Thinornis cucullatus*	A new addition to the Hunter Region checklist in July 2016.
Australian Painted Snipe *Rostratula australis*	Reclassified in 2013 as Endangered under the EPBC Act.
Eastern Curlew *Numenius madagascariensis*	Newly listed in 2015 as Critically Endangered under the EPBC Act.
Bar-tailed Godwit *Limosa lapponica*	The subspecies *menzbieri* (with no confirmed Hunter Region records) was newly listed as Critically Endangered under the EPBC Act in 2016 and the local subspecies *baueri* as Vulnerable.
Great Knot *Calidris tenuirostris*	Newly listed in 2016 as Critically Endangered under the EPBC Act and reclassified as Endangered on the IUCN Red List.
Red Knot *Calidris canutus*	Newly listed in 2016 as Endangered under the EPBC Act.
Curlew Sandpiper *Calidris ferruginea*	Newly listed in 2011 as Endangered under the TSC Act. Newly listed in 2015 as Critically Endangered under the EPBC Act.
Antipodean Albatross *Diomedea antipodensis*	Upgraded to full species, from formerly a sub-species of Wandering Albatross *D. exulans.* Both the nominate Antipodean Albatross *D.a. antipodensis* and Gibson's Albatross *D.a. gibsoni* are listed as Vulnerable under the EPBC Act. There are no changes to the listing under the TSC Act.
Buller's Albatross *Thalassarche bulleri*	Listed as Vulnerable under the EPBC Act (it is not listed under the TSC Act which is why it was not included into the previous paper (Roderick & Stuart 2010)).
Campbell Albatross *Thallassarche impavida*	Upgraded to full species, from formerly a sub-species of Black-browed Albatross *T. melanophrys*. It has been assumed that there were no changes to the conservation status that had been assigned to it as a sub-species.
Shy Albatross *Thallassarche cauta*	Upgraded to full species, i.e. split from being the nominate sub-species of Shy Albatross *T. cauta* from White-capped Albatross *T.c. steadi*.
White-capped Albatross *Thallassarche steadi*	Upgraded to full species, split from nominate sub-species of Shy Albatross *T. cauta*. The species is not listed as threatened under the EPBC Act as a distinct species, but has been presumed to be included within the former Shy Albatross *T. cauta* under the TSC Act.
Salvin's Albatross *Thallassarche salvini*	Upgraded to full species, from formerly a sub-species of Shy Albatross *Thallassarche cauta*. It has been assumed that there were no changes to the conservation status that had been assigned to it as a sub-species.
Australasian Bittern *Botaurus poiciloptilus*	Newly listed in 2011 as Endangered under the EPBC Act.
Black Falcon *Falco subniger*	Newly listed in 2013 as Vulnerable under the TSC Act.
Swift Parrot *Lathamus discolor*	Reclassified in 2016 as Critically Endangered under the EPBC Act.
Rufous Scrub-bird *Atrichornis rufescens*	Reclassified in 2015 as Endangered under the EPBC Act.
Painted Honeyeater *Grantiella picta*	Newly listed in 2015 as Vulnerable under the EPBC Act.
Regent Honeyeater *Anthochaera phrygia*	Reclassified in 2015 as Critically Endangered under the EPBC Act.
Dusky Woodswallow *Artamus cyanopterus*	Newly listed in 2016 as Vulnerable under the TSC Act.

Table 2. Threatened bird species of the Hunter Region.

Species	Conservation Status				Hunter Region			
	NSW	**EPBC**	**IUCN**	**APAB**	**Regional Status**	**Main Local Threats**	**Trend since 2010**	**Comments**
Emu *Dromaius novaehollandiae*	EP[#]	–	–	–	Uncommon resident.	Predation of chicks.	Low population in W of Region (not included in EP).	The NE population in the Region, which would form part of the EP, is probably extinct (the last confirmed record was in 1935).
Magpie Goose *Anseranas semipalmata*	V	–	LC	–	Resident.	Availability of suitable habitat.	Slightly increasing (now ~120 birds).	The population (which is derived from a re-introduction) remains confined to a few lower Hunter wetlands.
Blue-billed Duck *Oxyura australis*	V	–	NT		Rare visitor.	–	Regular records, although always of only 1-2 birds.	Predominantly a species of the southern Murray-Darling Basin.
Freckled Duck *Stictonetta naevosa*	V	–	LC		Uncommon visitor.	–	Greater numbers have been visiting since 2013 (up to ~150 birds).	Predominantly an inland species: the Hunter Region is a drought refuge.
Cotton Pygmy-goose *Nettapus coromandelianus*	E	–	LC		Accidental.	–	N/A (it is a vagrant).	There have been no records since 2002.
Wompoo Fruit-Dove *Ptilinopus magnificus*	V	–	LC		Resident.	Effects from climate change.	Small regional population; probably stable.	Considered likely to be resident, but there have been no breeding records.
Superb Fruit-Dove *Ptilinopus superbus*	V	–	LC		Accidental.	–	N/A (it is a vagrant).	There have been no confirmed records since 2009.
Rose-crowned Fruit-Dove *Ptilinopus regina*	V	–	LC		Accidental.	Much of the core range lies within areas zoned for conservation.	N/A (essentially a vagrant).	There was a spate of records in 2014 and some in 2015. Largely this reflected observer behaviour (i.e. repetitive visits to a known site where abundant fruit available and birds present).
Brolga *Antigone rubicunda*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	Birds were recorded near Nabiac in 2014 and Martindale in 2015 (only the second and third confirmed records for the Region).
Bush Stone-Curlew *Burhinus grallarius*	E	–	LC	–	Uncommon resident.	Predation, disturbance near nest sites, habitat modification.	Very small regional population; possibly it is stable.	At least six pairs in the Port Stephens area but with poor breeding success. Few records from elsewhere (and no breeding records outside Port Stephens).
Beach Stone-Curlew *Esacus magnirostris*	CE	–	NT	–	Rare resident.	Stochastic events impacting the very small population.	Increasing (from a very small base).	The Manning Estuary pair is having regular breeding success. A pair has established in Port Stephens and has raised several chicks.
Australian Pied Oystercatcher *Haematopus longirostris*	E	–	LC	–	Resident.	Disturbance along beaches in the breeding season, predation.	The non-breeding population is increasing. The smaller breeding population appears to be stable.	Breeding success continues to be poor. Recruitment to the non-breeding population is assumed to be mainly from outside of the Region.
Sooty Oystercatcher *Haematopus fuliginosus*	V	–	LC	–	Resident.	Disturbance, predation.	The non-breeding population is increasing. The smaller breeding population appears to be stable.	The breeding success rate is unclear as there are relatively few visits to offshore islands. Recruitment to the non-breeding population might be from outside of the Region.

[#]*The North Coast Bioregion (which lies partly within the Hunter Region) forms part of the Endangered Population (EP)*

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	**EPBC**	**IUCN**	**APAB**	**Regional Status**	**Main Local Threats**	**Trend since 2010**	**Comments**
Lesser Sand Plover *Charadrius mongolus*	V	E	LC	E	Uncommon summer migrant.	The main threat lies outside the Region: loss of key staging sites during migration.	Stable (with a very small base).	Reports have been confined to the Hunter Estuary. Small numbers, typically 1-5 birds, have visited each summer (*cf* many hundreds visiting in the 1970s).
Greater Sand Plover *Charadrius leschenaultii*	V	V	LC	V	Accidental summer migrant.	Loss of key staging sites (outside of the Region).	N/A (essentially a vagrant).	The recent records have been of 1-2 birds (briefly) in 2012, 2013 and 2016.
Hooded Plover *Thinornis cucullatus*	CE	V	V	V	Accidental.	Disturbance at breeding sites (outside of the Region)	N/A	The first confirmed record occurred in July 2016, a juvenile bird in the Worimi Conservation Lands along Newcastle Bight.
Australian Painted Snipe *Rostratula australis*	E	E	E	E	Rare summer migrant.	Loss of habitat.	Uncertain, as detection of this cryptic species is haphazard. The decline evident at a national level is probably occurring locally.	Sizable aggregations (4-19 birds) were recorded each year over 2011-14 but there have been no records since January 2014. The incidences of multiple records usually reflect follow-up observer effort after an initial sighting.
Comb-crested Jacana *Irediparra gallinacea*	V	–	LC	–	Uncommon resident.	Loss of habitat (many sites with records are on private property).	Probably stable. Reports are haphazard apart from at one key site, the Cattai Wetlands near Coopernook.	Birds breed at Cattai Wetlands and have been regularly recorded there in recent years. A pair bred at a known breeding site near Mulbring in 2010 but no birds have been reported from there since 2011.
Eastern Curlew *Numenius madagascariensis*	–	CE	E	V	Common summer migrant.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	Numbers in the Hunter Estuary and Port Stephens have been declining since 2014, after having appeared reasonably stable during 2010-13. There has been a small increase in numbers in the Manning Estuary.	Port Stephens and the Hunter Estuary are internationally significant sites. Both have routinely hosted 300+ visiting birds (>1% of total world population) over many decades. The Manning Estuary is of lesser importance, but it is nationally significant. See Discussion for additional comments.
Bar-tailed Godwit *Limosa lapponica baueri*	–	V	–	V	Common summer migrant.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	Numbers in the Hunter Estuary have been declining steadily, and declining also in Port Stephens.	The Hunter Estuary and Port Stephens continue to host 500-800 birds and with many juvenile birds over-wintering. The Manning Estuary also hosts 100-200 birds. However, notable declines are occurring. See Discussion for additional comments.
Black-tailed Godwit *Limosa limosa*	V	–	NT	NT	Summer migrant.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	A year-on-year decline in numbers has been occurring. This is a continuation of a longer term trend. The numbers now are 85-90% lower than in the 1970s.	The Hunter Estuary is now the only site where birds are recorded (it has always been by far the main site). Counts have decreased to 50-60 birds staying over the extended non-breeding season (with some counts during migration passage of ~100 birds).
Great Knot *Calidris tenuirostris*	V	CE	E	V	Uncommon summer migrant.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	Stable (with a very small base).	There have been very few records from outside of the Hunter Estuary. For decades, the numbers visiting have usually been low, apart from occasional exceptions.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	**EPBC**	**IUCN**	**APAB**	**Regional Status**	**Main Local Threats**	**Trend since 2010**	**Comments**
Red Knot *Calidris canutus*	–	E	NT	V	Summer migrant and bird of passage.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	The numbers visiting the Hunter Estuary have continued to decline.	There have been very few records from outside of the Hunter Estuary. See Discussion for additional comments.
Broad-billed Sandpiper *Calidris falcinellus*	V	–	LC	–	Rare summer migrant.	Loss of key staging sites (outside of the Region).	N/A (essentially a vagrant).	There were several records from the Hunter Estuary over 2012-14, with a peak count of six birds in January 2014 (*cf* many hundreds visiting in the 1970s).
Curlew Sandpiper *Calidris ferruginea*	E	CE	NT	V	Summer migrant.	Loss of key staging sites (outside of the Region) and loss of feeding and roosting sites locally.	Declining. Peak counts now (of ~100 birds) are around 50% of the numbers being recorded in 2010.	There has been a decline of ~95% in numbers visiting the Hunter Estuary each year. However, for 2013-2015 the numbers appear to have stabilised.
Sanderling *Calidris alba*	V	–	LC		Uncommon summer migrant.	Loss of key staging sites (outside of the Region).	Declining. Peak counts of 10-15 birds have been recorded in the Manning Estuary in recent years, *cf* 15-30+ birds during 2000-2010.	Most records are from the Manning Estuary, which was not often visited prior to about 2000. This makes it difficult to be clear about longer term trends. The Hunter Region seems never to have been a stronghold.
Terek Sandpiper *Xenus cinereus*	V	–	LC	–	Uncommon summer migrant.	Loss of key staging sites (outside of the Region).	The numbers visiting the Hunter Estuary have continued to decline. This is a continuation of a longer term trend.	There have been very few records from outside of the Hunter Estuary. The peak counts have now declined to fewer than 15 birds.
Red-backed Button-quail *Turnix maculosus*	V	–	LC	–	Accidental.	Loss of habitat.	N/A (essentially a vagrant).	There have been just two records since 2010 (from Crowdy Bay NP, December 2011 and Tuncurry, February 2014).
Grey Noddy *Procelsterna albivitta*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2002.
White Tern *Gygis alba*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been only 4 records since 2003 – including of a bird at Wybong (~125km from nearest coastline) in March 2015
Sooty Tern *Onychoprion fuscatus*	V	–	LC	–	Uncommon summer bird of passage.	–	Probably stable. In most years there have been just a handful of records, involving 1-3 birds.	In the wake of Cyclone Oswald (January 2013), many hundreds were recorded off the Region's coastline reflecting a NSW-wide phenomenon.
Little Tern *Sternula albifrons*	E	–	LC	–	Summer migrant.	Disturbance, predation, impacts from climate change (an increased frequency of extreme weather events).	The trend is uncertain but probably declining. Major Manning Estuary breeding colonies have been affected by loss of habitat through storms and siltation. Newly established breeding colonies elsewhere have experienced poor success.	The Manning Point sandspit disappeared in a 2011 storm event, while ongoing siltation at the Old Bar site has had a negative impact. Attempts at new colonies at Fern Bay (Newcastle Bight), Winda Woppa (Port Stephens) and Swansea (Lake Macquarie) have not fledged many chicks. Despite this, overall numbers in the Region continue to be high (500-700 birds).
Red-tailed Tropicbird *Phaethon rubricauda*	V	–	LC	NT	Accidental.	–	N/A (it is a vagrant species).	Recorded in 2011 and 2016.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	EPBC	IUCN	APAB	Regional Status	Main Local Threats	Trend since 2010	Comments
White-bellied Storm-Petrel *Fregetta grallaria*	V	V	LC	V	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2010.
Wandering Albatross *Diomedea exulans*	E	E	V	CE	Uncertain	The main threats lie outside the Region.	Probably stable. The frequency of recording has not changed.	Two recent records (in 2011 and 2012) have been of birds banded on the Crozet Islands in the southern Indian Ocean.
Antipodean Albatross *Diomedea antipodensis*	V	V	V	E	Uncommon winter migrant.	The main threats lie outside the Region.	Probably stable. The frequency of recording has not changed.	Includes two sub-species, *D. a. antipodensis and D. a. gibsoni* ("Gibson's Albatross"), which are recognised as separate species under some other taxonomic sources.
Grey-headed Albatross *Thalassarche chrysostoma*	-	E	E	CE	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	Two separate beach-cast birds were found along Newcastle Bight in 2014.
Black-browed Albatross *Thallassarche melanophrys*	V	V	NT	E	Common winter migrant.	The main threats lie outside the Region.	Probably stable. The frequency of recording has not changed.	Most sightings are of "Black-browed type" as it is difficult to separate Campbell and Black-browed Albatross unless close views are obtained.
Campbell Albatross *Thallassarche impavida*	V	V	V	V	Winter migrant.	The main threats lie outside the Region.	Probably stable. The frequency of recording has not changed.	Most sightings are of "Black-browed type" as it is difficult to separate Campbell and Black-browed Albatross unless close views are obtained.
Buller's Albatross *Thalassarche bulleri*	-	V	NT	NT	Uncommon winter migrant.	The main threats lie outside the Region.	Increasing.	Birds have become more regular visitors in winter since 2012.
Shy Albatross *Thallassarche cauta*	V	V	NT	V	Probably an uncommon winter migrant.	The main threats lie outside the Region.	Uncertain.	Separation from White-capped Albatross is difficult; most sightings are recorded as "Shy-type".
White-capped Albatross *Thallassarche steadi*	V	-	NT	V	Probably a common winter migrant.	The main threats lie outside the Region.	Uncertain (probably stable).	Separation from Shy Albatross is difficult; most sightings are recorded as "Shy-type". The TSC Act does not treat this as a distinct species.
Salvin's Albatross *Thallassarche salvini*	V	V	V	V	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	The TSC Act does not treat this as a distinct species. There were some reports from the period 2002-2008. These were not reviewed at the time as it was then being treated as a sub-species of Shy Albatross.
Northern Giant-Petrel *Macronectes halli*	V	V	LC	–	Uncommon winter migrant.	The main threats lie outside the Region.	Probably stable. However, there were no confirmed records in 2014 or 2015.	Giant-Petrels seen from land are hard to identify; they are considered more likely to be this species nowadays.
Southern Giant-Petrel *Macronectes giganteus*	E	E	LC	–	Uncommon winter migrant.	The main threats lie outside the Region.	Possibly declining. There have been relatively few reports since 2010.	No records in 2011 or 2013, 1-2 records per year in other years, which is in line with pre-2010 findings.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	EPBC	IUCN	APAB	Regional Status	Main Local Threats	Trend since 2010	Comments
Gould's Petrel *Pterodroma leucoptera*	V	E	V	V	Uncommon breeding summer migrant	Stochastic events impacting upon the relatively small breeding population. Prior threats managed.	Breeding range has further expanded. The trend was positive until 2015-16.	Predation rates have increased and the April 2015 storm damage on Cabbage Tree Island opened the breeding area to invasive weeds. See Discussion for additional comments.
Black-winged Petrel *Pterodroma nigripennis*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2007.
Providence Petrel *Pterodroma solandri*	V	–	V	V	Common autumn to spring visitor.	The main threats lie outside the Region.	Uncertain.	The usual peak counts are of 20-30 birds; in 2011-13 almost all counts were of <5 birds but 2014 and 2015 were normal.
Kermadec Petrel *Pterodroma neglecta*	V	V	LC	E	Uncommon summer visitor.	The main threats lie outside the Region.	Probably stable. There have been records of single birds in 2011, 2012, 2014 and 2016.	There also were several pre-2010 records.
Flesh-footed Shearwater *Ardenna carneipes*	V	–	LC	NT	Summer migrant.	The main threats lie outside the Region.	Probably stable locally, although there are threats at the breeding grounds.	Fewer birds were recorded in 2015 but no long-term trend has been noted.
Little Shearwater *Puffinus assimilis*	V	–	LC	V	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2007.
Black-necked Stork *Ephippiorhynchus asiaticus*	E	–	NT	–	Rare resident.	Inappropriate hydrological management practices.	Small regional population; probably stable. Breeding range may have expanded.	A pair appears to have bred in the Hunter Valley in 2015-16, for the first time.
Australasian Bittern *Botaurus poiciloptilus*	E	E	E	E	Rare resident.	Inappropriate hydrological management practices, climate change	Possibly declining. Impacted by returning of brackish/ saline waters to some previously occupied sites.	Tomago Wetlands no longer is suitable. Some freshwater habitat loss at Hexham Swamp also.
Black Bittern *Ixobrychus flavicollis*	V	–	LC	–	Rare resident.	Climate change (rising sea levels)	Small regional population; probably stable.	There are only a few records each year for this cryptic species.
Masked Booby *Sula dactylatra*	V	–	LC	NT	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	A bird of the race *fullagari* (which breeds on Lord Howe and Norfolk Islands) was recorded in 2013.
Osprey *Pandion haliaetus*	V	–	LC	–	Resident.	Water quality impacts affecting their feeding habitat.	Possibly increasing.	More than 25 breeding pairs estimated to be in the Region. The Hunter Estuary is the only site with no breeding records.
Square-tailed Kite *Lophoictinia isura*	V	–	LC	–	Uncommon resident.	Some of the local habitat is unprotected.	Small regional population; probably stable.	Most records are from the Maitland/Cessnock and Coopernook/ Harrington areas.
Little Eagle *Hieraaetus morphnoides*	V	–	LC	–	Resident.	Loss and degradation of woodland habitat.	Small regional population; possibly it is stable.	Widespread distribution, but there have been no breeding records since 2001.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	EPBC	IUCN	APAB	Regional Status	Main Local Threats	Trend since 2010	Comments
Spotted Harrier *Circus assimilis*	V	–	LC	–	Uncommon bird of passage.	Uncertain (not known to breed within the Region).	There has been an increase in the reporting rates and perhaps a range expansion.	Many more records since 2013, including some from NE of the Region and Broughton Island.
Eastern Grass Owl *Tyto longimembris*	V	–	LC	–	Rare resident.	Industrial developments around territories in the Hunter Estuary.	Uncertain.	The frequency of reporting has never been high. There have been no reports of the Crowdy Bay NP population since 2006; there is no reason to suspect it may be under threat although there were major fires in that area in 2014. Occasional reports continue to be received from within the Hunter Estuary.
Greater Sooty Owl *Tyto tenebricosa*	V	–	LC	–	Rare resident.	Much of the core range lies within areas zoned for conservation.	Probably stable.	The frequency of reporting has never been high.
Masked Owl *Tyto novaehollandiae*	V	–	LC	–	Rare resident.	Much of the core range lies within areas zoned for conservation.	Probably stable.	The frequency of reporting has never been high.
Powerful Owl *Ninox strenua*	V	–	LC	–	Resident.	Much of the core range lies within areas zoned for conservation.	Stable, possibly increasing.	Each year there are numerous records, from many different locations (including breeding records).
Barking Owl *Ninox connivens*	V	–	LC	NT	Rare resident.	Much of the core range lies within areas zoned for conservation.	Probably stable.	Core areas such as the Wollemi/Yengo wilderness are visited infrequently. There were regular 2014 and 2015 winter records from Green Point Lake Macquarie, considerably east of the usual range. Occasionally reported from Cessnock woodlands.
Black Falcon *Falco subniger*	V	–	LC	–	Uncommon resident.	Loss and degradation of woodland habitat.	Small regional population; probably it is stable.	Listed under the TSC Act in 2013.
Glossy Black-Cockatoo *Calyptorhynchus lathami*	V	–	LC	NT	Uncommon resident.	Much of the core range lies within areas zoned for conservation.	Probably stable.	There have continued to be frequent records from many parts of the Region, where *Allocasuarina* tree species exist.
Gang-gang Cockatoo *Callocephalon fimbriatum*	V	–	LC	–	Resident.	Most of the core range lies within areas zoned for conservation.	Probably stable.	There have continued to be frequent records from the southern parts of the Region, particularly from around and near to the Watagans.
Swift Parrot *Lathamus discolor*	E	CE	CE	E	Uncommon winter migrant.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Declining.	The local pressures (loss and threats of loss of habitat) compound the significant issues occurring at a national level. See Discussion for additional comments.
Turquoise Parrot *Neophema pulchella*	V	–	LC	–	Uncommon resident.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Uncertain. The regional population is small and dispersed, making it difficult to obtain a clear overall picture.	Several records have been received each year since 2010, including of the isolated population in Myall Lakes NP.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	**EPBC**	**IUCN**	**APAB**	**Regional Status**	**Main Local Threats**	**Trend since 2010**	**Comments**
Ground Parrot *Pezoporus wallicus*	V	-	LC	-	Probably extinct	The main threats lie outside the Region.	N/A (may be extinct).	There have been no records since 1935. This species was not discussed in Roderick & Stuart (2010), which focussed on modern records.
Little Lorikeet *Glossopsitta pusilla*	V	–	LC		Resident.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Possibly declining.	There have continued to be many reports each year, often of large feeding flocks; however, the reporting rates for 2013-15 were considerably below the long-term reporting rate.
Rufous Scrub-bird *Atrichornis rufescens*	V	E	E	E	Resident.	Climate change (leading to formation of high altitude "islands")	Stable, possibly declining.	Regular monitoring of a core population in the high altitude Gloucester Tops since 2010 suggests stability. However, there have been no records from lower altitudes where territories were previously known. See Discussion for additional comments.
Brown Treecreeper *Climacteris picumnus*	V	–	LC	NT	Resident.	Habitat loss and habitat fragmentation.	Probably declining. Although still common inland, and with consistent Atlas reporting rates, birds have disappeared from some areas.	One of the most easterly known breeding populations, at HEZ, remains under threat from development.
Painted Honeyeater *Grantiella picta*	V	V	V	V	Uncommon spring/summer visitor.	Loss of habitat. The majority of records are from private property in the Martindale valley.	Uncertain, probably stable. The regional population is small and unpredictable, making it difficult to obtain a clear overall picture.	Anecdotal reports continue to be received regularly, particularly from the Martindale Valley. Reporting Rates from the BirdLife Atlas suggest the population may be stable but there are limited data.
Black-chinned Honeyeater *Melithreptus gularis*	V	–	LC	NT	Uncommon resident.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Uncertain. The regional population is small and dispersed, making it difficult to obtain a clear overall picture.	Anecdotal reports continue to be received regularly. Reporting Rates from the BirdLife Atlas suggest the population may be stable but there are limited data.
Pied Honeyeater *Certhionyx variegatus*	V	–	LC		Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2008.
White-fronted Chat *Epthianura albifrons*	V	–	LC	–	Resident.	Loss of saltmarsh habitat from mangrove incursion and industrial development.	Probably increasing. However, the coastal population appears now to be restricted to the Hunter Estuary (few records for Manning Estuary or Port Stephens, although small numbers are occasionally reported from Newcastle Bight).	Restoration of tidal inundations at Tomago Wetlands and Hexham Swamp has proven very positive. Both sites host sizable populations (of 20-50 birds) and often with breeding records. The Ash Island population appears to have relocated to Hexham Swamp.
Regent Honeyeater *Anthochaera phrygia*	CE	CE	CE	CE	Uncommon bird of passage.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Declining.	The local pressures (loss and threats of loss of habitat) compound the significant issues occurring at a national level. See Discussion for additional comments.

Table 2. Threatened bird species of the Hunter Region cont.

Species	Conservation Status				Hunter Region			
	NSW	EPBC	IUCN	APAB	Regional Status	Main Local Threats	Trend since 2010	Comments
Speckled Warbler *Chthonicola sagittata*	V	–	LC	–	Resident.	Habitat loss, often from changed land management practices.	Probably stable, from a regional perspective. Birds have disappeared from some areas after land-use changes.	Atlas reporting rates have fluctuated year-on-year but are broadly stable over the long term. Understorey regrowth appears detrimental for this species.
Grey-crowned Babbler *Pomatostomus temporalis*	V	–	LC	–	Resident.	Habitat loss and fragmentation.	Apparently stable. The Atlas reporting rates have fluctuated year-on-year but are broadly stable over the long term.	Small groups continue to be reported frequently from across much of the Hunter Valley. However, some groups may be isolated populations that are in decline.
Varied Sittella *Daphoenositta chrysoptera*	V	–	LC	–	Resident.	Habitat fragmentation, habitat modification.	Declining. The Atlas reporting rates over 2010-2014 lie considerably below their long-term average.	Varied Sittella territories typically are 13-20 ha with a preference for rough-barked trees, hence their susceptibility to habitat fragmentation or modification.
Barred Cuckoo-shrike *Coracina lineata*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2004.
Olive Whistler *Pachycephala olivacea*	V	–	LC	–	Resident.	Climate change (leading to formation of high altitude "islands")	Apparently stable. Much of the core range lies within the Barrington Tops NP.	The Atlas reporting rates have increased since 2010 but this reflects increased survey effort in the Barrington Tops NP.
Dusky Woodswallow *Artamus cyanopterus*	V	–	–	–	Summer migrant	Habitat loss and fragmentation.	Probably stable.	There have continued to be occasional winter records.
White-eared Monarch *Carterornis leucotis*	V	–	LC	–	Accidental.	The main threats lie outside the Region.	N/A (it is a vagrant).	There have been no records since 2008.
Flame Robin *Petroica phoenicea*	V	–	NT	NT	Resident.	Losses of lowland wintering habitat. Much of the core breeding range lies within areas zoned for conservation.	Probably stable.	The increased Atlas reporting rates since 2010 reflects increased survey effort in the Barrington Tops NP.
Scarlet Robin *Petroica boodang*	V	–	LC	–	Resident.	Losses of lowland wintering habitat. Much of the core breeding range lies within areas zoned for conservation.	Probably declining. Since 2010, the long term reporting rate in the Atlas has decreased by 50% (with large year-on-year fluctuations).	There are no known breeding records for the Region. It is unclear to what extent the apparent decline is due to local threats *cf* issues occurring at the breeding areas.
Hooded Robin *Melanodryas cucullata*	V	–	LC	NT	Resident.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Possibly declining. The Atlas long term reporting rate has remained stable since 2010 but recent anecdotal evidence suggests otherwise.	It had been speculated that the decline which was evident pre-2010 may have been associated with severe droughts in the preceding years. See Discussion for additional comments.
Diamond Firetail *Stagonopleura guttata*	V	–	LC	–	Resident.	Ongoing loss of the preferred habitat on the Hunter Valley floor.	Declining. The Atlas long term reporting rate has steadily decreased since 2010, by ~40% overall.	The sowing of exotic grasses for pasture improvement is an additional negative factor for this species.

Species of Current Main Concern

Many threatened species are no longer recorded locally in the numbers that have historically been considered typical. For most, the main declines have occurred one or more decades ago and the local status has not changed greatly in recent times. The summaries for them in the previous review of Hunter Region threatened species remain broadly applicable, as do the threats they are experiencing (see Roderick & Stuart 2010 for details). However, nine species have been singled out below for a detailed discussion, for reasons which will become apparent.

Gould's Petrel *Pterodroma leucoptera*

The Gould's Petrel was reclassified from Endangered to Vulnerable under the TSC Act in 2009 following a highly successful recovery program. Apart from Cabbage Tree Island (CTI; the predominant breeding island) and other islands off Port Stephens where the species is now known to breed, Gould's Petrels have also been found breeding on Montague Island, on the NSW Far South Coast, where up to 5 pairs have been recorded in burrows (N. Carlile pers. comm.). Notwith-standing, it occurs in very low numbers on all but CTI and remains vulnerable to stochastic events there.

Such an event took place in April 2015, when an intense low pressure system along the east coast of NSW unleashed gale-force winds and torrential rain, resulting in damage to and loss of thousands of trees in parts of the Hunter Region. Extensive damage was noted on CTI, in particular the southernmost of the two rainforest gullies where Gould's Petrel burrows exist (T. Clarke pers. comm.). This has resulted in the opening of the rainforest canopy, thus benefitting 'light-seeking' invasive weeds such as Morning Glory *Ipomoea carnea* (which has been known to inhibit access for birds to their burrows). It is also likely that the more exposed nature of the gully would also benefit avian predators, such as corvids and Pied Currawongs *Strepera graculina*.

During routine nest-site surveys undertaken on CTI in November 2015, many carcasses of adult Gould's Petrels were found on and near the ground in the western gully. It is not unusual to find small numbers of carcasses, but the number found during this survey was significantly higher than had previously been recorded (T. Clarke pers. comm.). It is not clear why this occurred, though the loss of trees/cover may be a factor.

It is also possible that at-sea threats are having an impact on foraging adults; a possibility supported by seabird researchers (D. Portelli pers. comm.). The at-sea distribution of Gould's Petrels is becoming better known, following the use of satellite tracking devices, and has been found to be more extensive than first thought (e.g. see Priddel *et al.* 2014). It is possible that birds are foraging over a wider area now, in search of food/prey items.

The long-term outlook for Gould's Petrel in the Hunter Region is difficult to assess, but it is clear that ongoing management of recovery actions previously undertaken at nesting areas, in particular on CTI, needs to take place. However, the expansion of the species' breeding range is a positive development.

Eastern Curlew *Numenius madagascariensis*

The Eastern Curlew was added to the EPBC Act's list of threatened species in 2015. It was immediately listed as Critically Endangered, reflecting the drastic population decline which has occurred in recent years. In the Hunter Region, two sites have long been considered to be internationally significant for Eastern Curlew – the Hunter Estuary and Port Stephens. Both sites have regularly hosted more than 1% of the total world population of ~30,000 individuals (Bamford *et al.* 2008). Declines are occurring at both locations, but in particular the Hunter Estuary based on monthly counts (Stuart *et al.* 2013). **Figure 1** shows the annual peak and mean summer counts for the estuary. The mean summer counts for any given year are the average of the January-March and September-December counts for that year. The trends are also summarised in **Table 3**.

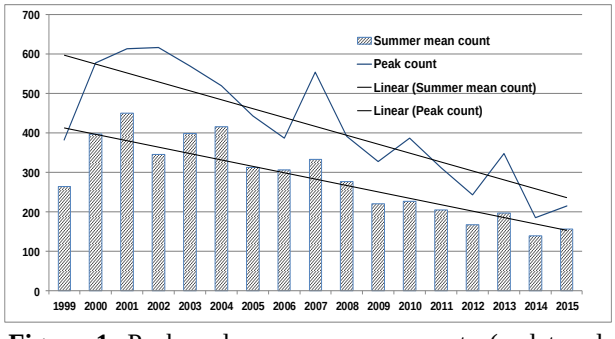

Figure 1. Peak and mean summer counts (and trend lines) for Eastern Curlew in the Hunter Estuary 1999-2015

Eastern Curlew counts in the estuary have declined by 6.2% year-on-year based on peak counts (or by 4.5% based on mean summer counts). Clemens *et*

Table 3. Average annual declines for selected shorebirds

	Eastern Curlew	Bar-tailed Godwit	Black-tailed Godwit	Red Knot
Hunter Estuary peak counts 1999-2015	6.2%	15.7%	4.5%	6.0%
Hunter Estuary mean summer counts 1999-2015	4.5%	9.6%	1.9%	N/A
Port Stephens summer counts 2004-2015	2.9%	4.0%	N/A	N/A
Gir-um-bit NP peak counts 2000-2015	2.1%	0.7%	N/A	N/A
Gir-um-bit NP mean summer counts 2000-2015	3.1%	0%	N/A	N/A
Manning Estuary peak counts 2008-2015	0%	3.2%	N/A	N/A
Manning Estuary mean summer counts 2008-2015	-0.3%	1.8%	N/A	N/A

al. found that the southern population of Eastern Curlew (birds occurring south of 27.8^{0}S) was decreasing at an average of 6.95% per annum (Clemens *et al.* 2016). The Hunter Estuary rates of decline appear to be in line with the changes happening across southern Australia. Since 2012, the Hunter Estuary no longer has hosted an internationally significant population of Eastern Curlew.

In Port Stephens (**Figure 2**, also **Table 3**), the situation is similar to the Hunter Estuary although the year-on-year declines are smaller. **Figure 2** is based on counts at the main roost site (Gir-um-bit NP), which have been done monthly since 2000. Also included in **Table 3** are the trends from one-off summer surveys (since 2004) for all of Port Stephens. Based on peak counts, Port Stephens continues to be internationally significant for Eastern Curlew, although perhaps for not much longer if the trends continue.

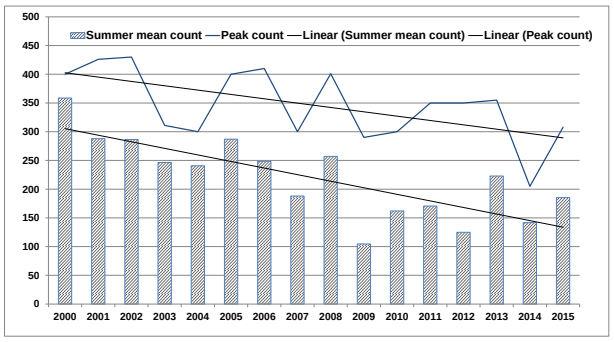

Figure 2. Peak and mean summer counts (and trend lines) for Eastern Curlew at Gir-um-bit NP 2000-2015

It is interesting that in the Manning Estuary, which hosts a smaller population (highest recent count has been 49 birds), the counts are stable (**Table 3**). A very small population (usually <5 birds) is also regularly recorded in the Swansea/Lake Macquarie area.

Bar-tailed Godwit *Limosa lapponica*

In 2015, the subspecies of Bar-tailed Godwit regularly occurring in the Hunter Region (*L. l. baueri*) was listed as Vulnerable under the EPBC Act. The Hunter Estuary and Port Stephens have always hosted large numbers in the austral summer (also many over-wintering juvenile birds). Smaller populations are also present each year in the Manning Estuary and Swansea/Lake Macquarie.

The situation in the Hunter Estuary is not encouraging. Although 600-700 birds continue to visit each year, this represents a substantial decline from previous years (**Figure 3**, **Table 3**). The year-on-year decreases since 1999 have been of the order of 10-15%, for the mean summer and peak counts respectively. These changes are notably worse than for southern Australia more generally, where the population was found to be decreasing at only 1.33% per annum (Clemens *et al.* 2016).

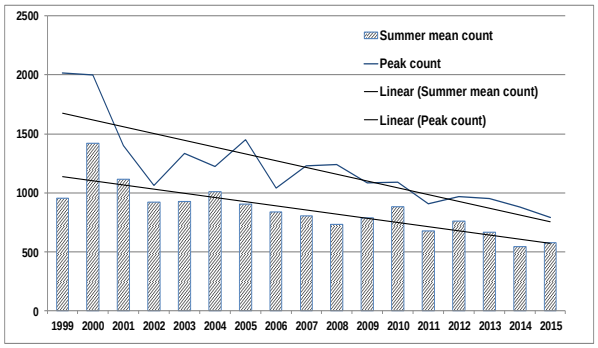

Figure 3. Peak and mean summer counts (and trend lines) for Bar-tailed Godwit in the Hunter Estuary 1999-2015

Declines are also occurring in Port Stephens, although not as markedly. Gir-um-bit NP is an intermittent roost site for Bar-tailed Godwits and the counts there fluctuate accordingly with no obvious trend (**Table 3**). However, the summer counts for all of Port Stephens (for 2004-2016, after the surveys began) indicate a 4% year-on-year decline in numbers (**Figure 4**, **Table 3**). However, a limitation for making any firm conclusions is that the data set for all of Port Stephens contains only 13 summer records, and potentially is affected by variables such as weather conditions on the survey date.

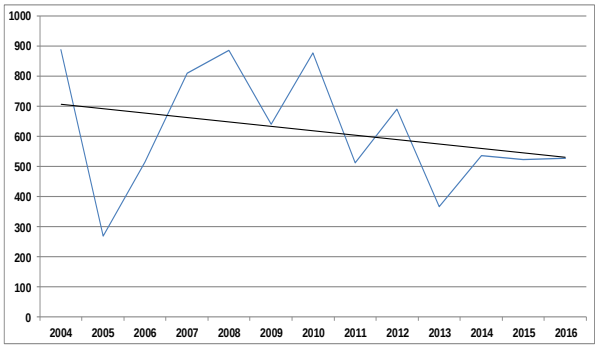

Figure 4. Summer counts (and trend line) for Bar-tailed Godwit in Port Stephens 2004-2016

Counts in the Manning Estuary have also been decreasing, by some 2-3% per year on average (**Table 3**). Therefore, the decline in Bar-tailed Godwit numbers in the Hunter Estuary is substantially greater than the declines being seen elsewhere in the region and in southern Australia more generally.

Black-tailed Godwit *Limosa limosa*

Black-tailed Godwits are rarely recorded away from the Hunter Estuary. The population visiting each year has been decreasing for several decades (Roderick & Stuart 2010). This trend has been continuing (**Figure 5**, **Table 3**) and the average decline of 4.5% per annum since 1999 exceeds the 3.22% rate of decline found for southern Australia as a whole (Clemens *et al.* 2016). The situation possibly has stabilised in very recent years. However, the visiting population is now only 100 or so birds and therefore is very susceptible to stochastic events. An ongoing monitoring program will be essential for providing fresh insights into the regional outlook for this species.

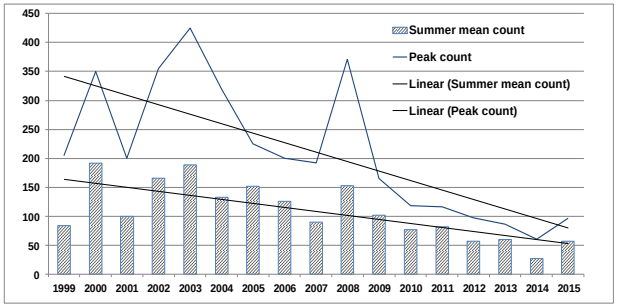

Figure 5. Peak and mean summer counts (and trend lines) for Black-tailed Godwit in the Hunter Estuary 1999-2015

Red Knot *Calidris canutus*

The Red Knot was newly listed as Endangered in 2016 under the EPBC Act. It is difficult to be certain what is happening locally. The Hunter Estuary is the only important location for Red Knot in the Hunter Region. Birds are rarely recorded anywhere else, and only ever in low numbers. In the Hunter Estuary, most records have been for birds on migration passage in spring and early summer. Outside of the period September to November, only a few tens of Red Knot usually are present and no obvious trend can be discerned. During the migration period, large numbers pass through the estuary, mainly staying for only a relatively short time (L. Crawford & C. Herbert pers. comm.). This constant flux of migrating birds has made it difficult to assess the population dynamics. Based on peak counts (**Table 3**) there has been a 6% year-on-year decline since 1999; however, this interpretation may be being distorted by apparently abnormally high peak counts of 1,472 birds in 2006 and 1,100 birds in 2001. In most years, the peak potentially has been missed, as it would have required daily monitoring at all potential sites. The overall Hunter Estuary is only surveyed monthly, although Stockton Sandspit (an important Red Knot site) is visited somewhat more frequently.

Most probably, the numbers of Red Knot on passage through the Hunter Estuary are decreasing in line with the national trend, which is an annual decline of 5.64% in southern Australia (Clemens *et al.* 2016) but this is difficult to prove.

Swift Parrot *Lathamus discolor*

The Swift Parrot was reclassified from Endangered to Critically Endangered under the EPBC Act in May 2016. This was due predominantly to the emergence of severe threats from an introduced predator (Sugar Glider *Petaurus breviceps*) on the breeding grounds in Tasmania (Stojanovic *et al.* 2014). Population declines of 79-95% over three generations have been predicted (Heinsohn *et al.* 2015). Therefore, the predominant short-term threats to the species lie external to the Region.

Garnett *et al.* (2011) estimated the total Swift Parrot population at around 2,000 mature individuals and declining. Frequently, 100 or more birds visit the Region in winter, representing ~5% or more of the total estimated population (e.g. Stuart 2011-2016). In 2016 over 200 birds have been accounted for in the Region (BirdLife Australia unpublished data), further highlighting the importance of the Region for this species. It is difficult to quantify how the availability of habitat locally for winter-foraging is likely to affect the status of the species overall. However, there is evidence for site fidelity, with frequent records from the same few locations, and this might

increase the vulnerability of Swift Parrots to stochastic local events.

Records continue to be reasonably widespread. Surveys at the Singleton Training Area (Australian Department of Defence lands) are consolidating that area, which is under no apparent threat of loss or change, as one of the most important sites in the Hunter Valley for Swift Parrots, with 5 years of consecutive usage and recent records of >130 birds (HBOC unpublished data). However, some of the other most important recognised sites where the highest levels of site fidelity have been shown (e.g. HEZ) continue to be under threat.

It seems reasonable to conclude that any threats to habitat shown to be important for a critically endangered species should be considered significant. Whilst the impacts of predators and habitat loss on the breeding grounds is of utmost immediate concern, any continuing loss or fragmentation of winter foraging habitat should also be viewed as further compromising the viability of the species. As such, the long-term outlook for Swift Parrots in the Hunter Region cannot be considered secure. The threats locally have not diminished at all since the 2010 review (Roderick & Stuart 2010).

Rufous Scrub-bird *Atrichornis rufescens*

The Rufous Scrub-bird was reclassified from Vulnerable to Endangered under the EPBC Act in 2015. This was because of increasing evidence of susceptibility to climate change. Systematic surveys in the Gloucester Tops over 2010-2015 failed to find any previously known nor any new scrub-bird territories below 1,100m (Newman *et al.* 2014, Stuart & Newman unpublished). Retreat to higher altitudes as a result of climate change was predicted (Garnett *et al.* 2011) and has also been found to be occurring with other scrub-bird populations (Andren 2016). There is also evidence of increased clustering of territories in the Gloucester Tops with implications that the suitability of the habitat is changing (Newman *et al.* 2014).

Susceptibility to drought has also been noted. In two breeding seasons which had abnormally low rainfall (spring of 2012 and 2013), many male scrub-birds ceased to advertise their territories and possibly therefore did not breed (Newman *et al.* 2014).

All of the Rufous Scrub-bird range in the Gloucester Tops lies within reserves, with well-protected habitat. However, if the effects from climate change continue to manifest as predicted, the amount of suitable habitat will shrink further – and it seems unlikely that essentially flightless scrub-birds would be able to re-locate to elsewhere (without human intervention). However, there is a record of an immature Rufous Scrub-bird from a lowland site a considerable distance from any known population (Boles & Tynan 1994).

Regent Honeyeater *Anthochaera phrygia*

The Regent Honeyeater was reclassified from Endangered to Critically Endangered under the EPBC Act in June 2015. This was because the species was recognised as having undergone an 80 percent population decline in three generation lengths (approximately the past 24 years) and that the threats most likely to have caused these declines continue to occur (Department of Environment 2015).

Although habitat loss and fragmentation are almost certainly the key drivers for the imperilled status of the Regent Honeyeater, contemporary threats, in particular from aggressive native bird species, continue to drive the rapid declines. In 2015, low nesting success rates were recorded in the Capertee Valley, the only region where nesting was recorded that year. This was due to several factors, but predominantly due to disturbances/predation at nest sites from species such as Noisy Friarbirds *Philemon corniculatus*, Noisy Miners *Manorina melanocephala* and Pied Currawongs *Strepera graculina* (R. Crates pers. comm.).

In the Region, very few Regent Honeyeaters have been recorded since the last major blossom event of Spotted Gum *Corymbia maculata* in 2012. In autumn/winter 2016, Spotted Gums again flowered but the 2016 event was not comparable with 2012 (M. Roderick pers. obs.; S. Roderick pers. obs.). At least 100 birds were present in the forests of the lower Hunter in 2012 (Roderick & Ingwersen 2012). At that time, this was thought to be conservatively at least 10% of the then-estimated total population, with current estimates putting the population at between 350 and 400 adult birds (Garnett *et al*. 2011; Regent Honeyeater Recovery Team, unpublished data).

The long-term outlook for Regent Honeyeaters in the Hunter Region is similar to that of the species as a whole: of utmost concern. Within the Region, the key actions that will likely benefit the conservation of this species include protection of

key areas of habitat (such as within HEZ), control of invasive native species that are known to have deleterious effects (e.g. Noisy Miners) and continued monitoring. BirdLife Australia is currently working with government agencies, landholders and other stakeholders in achieving the above in the Lower Hunter Valley IBA.

Hooded Robin *Melanodryas cucullata*

The Hooded Robin has continued to decline in the Hunter Region, evidenced by analysis of BirdLife Australia Atlas data (see **Figure 6**), as well as anecdotally by a failure to record the species at numerous sites where it once occurred (authors' pers. obs.; various communications with other observers). Very few Hooded Robins are reported to HBOC nowadays and often the sites where they are reported from are 'known' sites where individuals or family groups are persisting. It is notable that there have been only two confirmed breeding records since 2003 (Stuart 2004-2016).

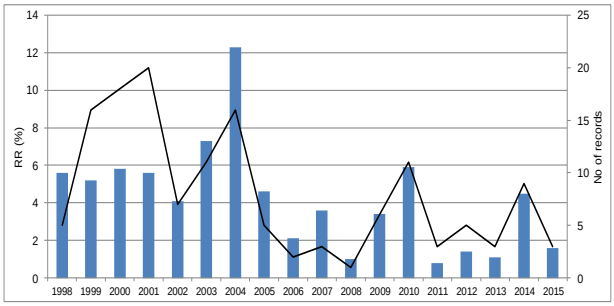

Figure 6. Hooded Robin annual Reporting Rates and number of records

The annual Reporting Rates for Hooded Robin from the Atlas, and the number of records per year, are shown in **Figure 6**. There is clear evidence of decline, although this is masked by two abnormal years, 2010 and 2014. In both years, an uncommon species was reported from nearby to a Hooded Robin territory. This resulted in an increased frequency of visits by observers and a corresponding increase in the number of Hooded Robin records, as **Figure 6** shows. In contrast, 2004 appears to have been a genuinely good year (interestingly, there was a strong La Niña event during 2001-2003).

The RRs for the periods 1998-2005 and 2006-2015 are shown in **Table 4**. For the reasons discussed earlier, data from 2010 and 2014 have been excluded from the latter period. The decline in the past ten years has been very dramatic. The distribution range also appears to have contracted. Birds were recorded in 21 10-minute cell blocks over 1998-2005, compared with only 14 cells more recently (**Table 4**).

Table 4. Hooded Robin Atlas data

Period	RR for period	No. of cells
1998-2005	6.9%	21
2006-2015 (not 2010, 2014)	1.8%	14

It is very difficult to determine what is driving these declines, but other species with similar habits (e.g. Red-capped Robin *Petroica goodenovii*) may also be affected by the same factors. Ground-foraging woodland birds are thought to be amongst the most threatened guild of woodland birds, with the Hooded Robin having been described as a "standout" declining species (Reid 1999). Factors cited were the loss and fragmentation of habitat, weed infestation, loss of native seed-producing grasses and structural changes. These threats are doubtless occurring in the Hunter Region and whilst they are likely to place several other species at risk of further declines, the Hooded Robin appears to be declining more rapidly than others.

Very little suitable habitat for Hooded Robins exists in conservation reserves in the Region, with the vast majority lying on private properties; much of that is threatened with degradation or destruction (e.g. on coal mine leases). Although private land conservation initiatives have been undertaken in the Region (e.g. by BirdLife Australia), the long-term outlook for Hooded Robins in the Region continues to be of great concern. It is facing local extinction if the rates of decline continue unabated.

CONCLUSIONS

The Hunter Region hosts 89 species or sub-species listed as threatened under the TSC and/or EPBC Acts, or under an IUCN classification. This includes 38 breeding resident species and a further 13 migratory species which occur in the region every year (and in some cases, are known to breed locally e.g. Gould's Petrel *Pterodroma leucoptera*, Little Tern *Sternula albifrons* and Regent Honeyeater *Anthochaera phrygia*). For these 51 species, the Hunter Region provides important habitat on an ongoing basis. The Region is also a drought-refuge for several threatened species e.g. Blue-billed Duck *Oxyura australis* and Freckled Duck *Stictonetta naevosa*, and at least eight pelagic seabird species are regularly recorded offshore.

The prospects for many of the threatened species do not seem encouraging. Nine species appear to have poor prospects unless current trends can be

reversed. Very few species appear to have had their prospects improved since the previous review of threatened species in 2010. The threats discussed in the 2010 review largely remain unabated. Until actions are taken to more adequately prevent the loss and fragmentation of habitats for threatened species and to conserve areas where such species are known to be present, it is very likely that the majority of the threatened species populations of the Hunter Region will continue to decline.

Future Updates

How threatened and near-threatened species respond to threats is dynamic. Hence, conservation classifications can be expected to be in almost continuous flux. Updates produced every few years in articles such as this quickly become dated. Therefore, a searchable electronic version of **Table 2** will be made available on HBOC's website (at www.hboc.org.au/conservation/). In future, the on-line version should be considered the source of current information about the conservation status of Hunter Region species.

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Selection of nocturnal roost sites by waders in the Hunter Estuary

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During the winter of 2004 a study was conducted on the niche of the Bar-tailed Godwit *Limosa lapponica* in the Hunter River Estuary, i.e. about the details of all its interactions with the various habitats it uses and with other species, avian and otherwise. This species was chosen, because it uses the estuary in good numbers and is gregarious with other waders, so any findings might be used as a starting point to propose studies into the wider wintering wader flock. The study sought to answer fundamental questions about the way Bar-tailed Godwit use the estuary. This included the identification of all sites it uses for roosting and foraging, and whether changes in environmental conditions, including night/day, high/low-tide, and different weather conditions, changed the way the birds used the estuary (Richardson 2004).

Up until the 2004 study, local bird researchers had gained a general understanding of the way migratory waders used the estuary, supported by a study conducted by David Geering (1995). Yet much of the observation was limited to daylight hours. As a consequence of remaining gaps in knowledge of nocturnal habits, our winter 2004 study employed many more radio transmitters. This allowed observation of the activities of 15 Bar-tailed Godwit around the clock to determine if there were areas of important foraging and roosting habitat that were previously unknown. The study also hoped to determine if wintering Bar-tailed Godwit solely used sites on the Hunter Estuary. Would there be times when the estuary could not fulfil all their requirements and they might move to another?

The key findings of the study (Richardson 2004) were that Hunter Bar-tailed Godwit remain in the estuary throughout the austral winter, and in relation to their foraging habits they are essentially birds of the tide. However, the study showed that while there was a reliable predictability regarding their foraging on the same low-tide mudflats, despite differences in time of day or different weather conditions, the usage of roosting habitats was an entirely different matter. Time and again the birds observed a clearly demarcated difference in the use of roosting habitats between daylight and night-time hours. This aspect of their behaviour, involving the complete rejection of their diurnal roosts at night, had not been previously documented in the Hunter Estuary.

During daylight hours Bar-tailed Godwit habitually used the same roosting habitats that were close to the areas in which they foraged, such as Kooragang Dykes and Stockton Sandspit; yet at night they used a range of different locations spread across the Ash and Kooragang Islands for unpredictable periods of time. So strong was the impetus to vacate daylight roosts during the hours of darkness that even when they were settled on the dykes before sunset, they would leave for the island roosts before it was completely dark.

Every other part of their daily regime was governed by the tide, yet the reason for their exclusive use of more distant roosts away from the foraging areas at night, remained unresolved and the number of consecutive nights they spent at any one of their night-time roosts appeared completely random. They might use one roost for two weeks, or another for three days, and then inexplicably discard those roosts for another, with no tidal, day cycle or weather cues to suggest a reason for the shift.

However, as the study progressed the reason the birds avoided day roosts at night emerged and it had nothing to do with the tide or the weather, but appeared to be influenced by the time of day. Many of the roost sites the birds were using had signs of fox use. Equipment left on the dykes was marked by foxes; fox scats and footprints were found at Stockton Sandspit; the beach at Barry Shearman's farm in Fullerton Cove had apparently been discarded as a roost site and there were fox footprints in the beach's sand; and one night on Ash Island's Wader Pond a fox casually loped through the pond before us as if it was part of its

nightly regime. Further to these observations an oyster fisherman had related to me a first-hand observation of a fox swimming across a wide stretch of the Hunter River, so it was obvious that water was no barrier to foxes. Although foxes sometimes forage during the day the majority of foraging movements by foxes locally are undertaken at night. The threat of foxes might thus be the reason behind the nocturnal roost-site selection of the birds.

Although it was beyond the resources of the 2004 study to scientifically verify all the findings, here was a mechanism that could explain why diurnal roosts such as Stockton Sandspit and the dykes, which are used every day by waders, were avoided as important roost sites at night. Such places would likely be visited every evening by foxes, for the bird-scent induced hope of the easy meal, which a sick, deceased or nesting bird would represent.

Furthermore, only the fox hypothesis appeared to be capable of explaining the random nocturnal roost changing conundrum. It appeared that the birds would only remain at one of the nocturnal roost sites as long as it took the foxes to find where the birds were roosting. The birds would be flushed from the current roost, and then the fox and wader interaction clock would reset.

Aggregations of wading birds roosting at night would likely represent an important food resource for foxes to target, so the limited number of suitable roost sites close to the foraging areas could mean that the birds would be disturbed too regularly for these sites to be useful for them at night. Diurnal use of these roosts is apparently safer, since the same fox surprise-attack circumstances would not be present in daylight hours because the birds would easily see foxes approaching from a distance. On the other hand, during nocturnal hours it appeared that Ash Island represented a large area encompassing many potential roosting sites, a number of which were associated with water. Shallow water roosts may make the approach of foxes more detectable by the birds, while the larger area and number of potential roost sites offered by Ash Island may make the birds more difficult for foxes to find.

While the 2004 Hunter Estuary study's data establishes that Bar-tailed Godwits' diurnal and nocturnal roost selection is markedly different, there have been no direct observations to conclusively establish that fox behaviour is the prime driver in the birds' strategy to vacate diurnal roosts during nocturnal hours, nor that foxes are solely responsible for the birds' seemingly random changes of nocturnal roosting habitats. While the reasoning postulated appears quite plausible, and likely to be at least part of the explanation, these hypotheses are based on circumstantial evidence, which requires validation. Therefore there remains a gap in the data, which may be filled easily by setting up remote cameras at nocturnal roost sites in order to determine the fit of these hypotheses.

The implication of the study's findings is that migratory waders within the Hunter Estuary require a much greater area for roosting than is apparent from daytime survey data alone. This would appear to be the case even if foxes are not as important a factor as our provisional conclusion has postulated. Furthermore, if such a dependence on different roosting habitats during nocturnal hours applies in the Hunter Estuary, then the same greater variety of roosts will likely be required in other estuaries.

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Roosting oystercatchers at Swan Bay, Port Stephens, NSW

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Wader counts conducted by Hunter Bird Observers Club (HBOC) members since 2004 have identified the quiet shoreline of Swan Bay in Port Stephens NSW (32^{0}41'48.55"S, 151^{0}58'45.65"E), with its oyster-farm breakwater and associated oyster poles, as an important site for viewing a variety of waders and waterbirds (Stuart 2005). When the Port Stephens-Great Lakes Marine Park was created, in December 2005, the location fell within the Swan Bay Sanctuary Zone and local oyster farming ceased. During 2012 the oyster processing shed was dismantled, but the cement pad, which had supported it along with its rocky breakwater, was retained.

Prior to demolition of the shed up to six Australian Pied Oystercatchers *Haematopus longirostris*, and one to two Sooty Oystercatchers *Haematopus fuliginosus* were occasionally seen roosting on the breakwater. Both species are classified as Endangered and Vulnerable, respectively, under the *NSW Threatened Species Conservation Act 1995* (NSW Scientific Committee 2008a, 2008b). Larger groups of Pied Oystercatchers (often 20+) roosted on Orobillah Island (32^{0}41'48.55"S, 151^{0}58'45.65"E) and at the south-east end of Gur-um-bit National Park (NP) (32^{0}42'29.28"S, 151^{0}58'11.90"E). These sites lie approximately 1.25km east, and 1.67km south-east of the breakwater, respectively, at locations presenting difficult access and restricted visibility.

Figure 1. Swan Bay oyster farm site

From an aerial perspective, the newly cleared cement slab resembled an unobstructed landing pad (**Figure 1**), a fact that did not go unnoticed by Caspian Terns *Hydroprogne caspia* and Silver Gulls *Chroicocephalus novaehollandiae*, but the site was almost immediately appropriated by Pied and Sooty Oystercatchers as a roost (**Figure 2**). Except during inclement weather, both species of oystercatcher continue to dominate the approximately 12m x 8m site by sheer force of numbers. They defend it from interlopers such as Pacific Black Ducks *Anas superciliosa* and Chestnut Teal *Anas castanea*, but gulls and terns are tolerated.

Figure 2. Oystercatchers roosting on concrete slab at oyster farm site (Tide level: 1.7m).

The location benefits both birds and birders. For oystercatchers, the site, although exposed to the elements and frequent raptor patrols, offers a roost with excellent predator visibility and minimal human disturbance. For birders, the site offers easy access to a prime monitoring location that contributes data which may eventually help to resolve the question of why so many Australian Pied Oystercatchers of reproductive age congregate within the estuary but do not breed.

Sooty Oystercatchers prefer to breed on the offshore islands (NSW Scientific Committee 2008a). The steady increase in numbers seen within the estuary probably reflects successful off-shore breeding events in response to advantageous off-shore and on-shore habitat. Conversely, Pied Oystercatchers, though frequently seen feeding in

pairs, nest sparsely, and often unsuccessfully, along the sandy shores of Stockton Beach and similar locations. There are only two known breeding attempts within the estuary, a nest at Corrie Island which contained eggs (Lawrence Penman *pers. comm.*) and another at Orobillah Island (G. Little *pers. comm.*, rep. Stuart 2011). The fate of both nests is unknown.

HBOC data gathered from monthly land-based wader counts, in combination with biannual boat surveys, continue to confirm that the sheltered shoreline of Port Stephens, the largest estuary in NSW, is a haven of national significance for Australian Pied Oystercatchers (Stuart 2011). Annual high counts (2008-2015) show increased use of the Oyster Farm roost (Pied Oystercatchers, 3-57; Sooty Oystercatchers 1-28). This development involves a large proportion of both species of oystercatcher in Port Stephens, and highlights the importance of the new roosting location. (**Tables 1** and **2**).

Benthic biomass collections at ten sites around the relatively undeveloped 288km shoreline, including Swan Bay, confirm the abundance of pipis *Plebidonax deltoides* (Stuart & Wooding unpublished data). Pipis are reported to be a dietary preference for Australian Pied Oystercatchers (Jones 2016; Owner & Rohweder 2003). Given that food, shelter and reproduction are the driving forces for survival it is concerning that Port Stephens only seems capable of satisfying the first two of these three prerequisites for a species classified as Endangered in NSW.

Boat surveys, encompassing the entire Port Stephens estuary on the same high tide, indicate that Australian Pied Oystercatcher numbers in the estuary have remained steady (HBOC Annual Bird Reports 2008-2014). Increased numbers at the oyster farm roost since December 2012, might mean that these birds were always present, but not previously visible to land-based surveyors, or perhaps the site has attracted oystercatchers from other parts of the estuary. Reduced count numbers at Orobillah Island and Gur-um-bit NP seem to confirm the oyster farm site as the current, primary, fair-weather roost for the estuary's west-end oystercatchers; increased count accuracy is a beneficial consequence (**Tables 1** and **2**).

The diminished presence of roosting oystercatchers at Orobillah Island and Gur-um-bit NP gives rise to speculation regarding the increased potential for Pied Oystercatchers to nest at these locations. Both sites are difficult to access, and therefore relatively secure from anthropogenic stress. Both are more sheltered and offer more cover from raptors than ocean-beach sites, although fox predation might be a concern. Neither site has ever undergone a systematic assessment. Given the changed circumstances, and the Endangered status of the Australian Pied Oystercatcher, this would seem to be a project worthy of future consideration.

Table 1. A comparison of annual highest-count data for Pied Oystercatchers from: Biannual HBOC boat surveys, Port Stephens; Monthly Swan Bay Wader Surveys; Oyster Farm site.

Survey Site	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
HBOC Boat Survey	154	134	148	166	192	130	162	164
Swan Bay Wader Counts	18	35	20	20	50	47	41	46
Oyster Farm Site	3	4	6	6	36	38	46	57
% of HBOC Total - Swan Bay	11.7	26.1	13.5	12.5	26.0	36.2	25.3	28.0
% of HBOC Total - Oyster Farm	1.5	3.0	4.1	3.6	18.7	29.2	28.4	34.8

Table 2. A comparison of annual highest-count data for Sooty Oystercatchers from: Biannual HBOC boat surveys, Port Stephens; Monthly Swan Bay Wader Surveys; Oyster Farm site.

Survey Site	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
HBOC Boat Survey	14	13	24	19	28	42	37	52
Swan Bay Wader Counts	2	2	3	3	4	11	18	28
Oyster Farm Site	1	1	4	3	4	11	17	28
% of HBOC Total - Swan Bay	11.7	26.1	13.5	12.5	26.0	36.2	25.3	28.0
% of HBOC Total - Oyster Farm	7.1	7.7	16.7	15.8	14.3	26.2	46.0	53.8

Notes: 1. Oyster Farm figures include counts by the author on and between official survey dates.
2. Years 2008-2015 represent years when the author participated in Swan Bay wader counts.

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New Australian White Ibis rookery at Salamander Bay

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Australian White Ibis *Threskiornis moluccus* have established a new rookery at Salamander Waters Estate, Salamander Bay, NSW (32^{0}43'33.48"S, 152^{0}04'48.65"E). The new location is approximately one kilometre from a long-established colony in the Wanda Wetlands (32^{0}43'50.85"S, 152^{0}04'48.65"E). Whether the new colony is the result of over-population at the Wanda Wetlands site or an influx of new "urban ibis" to the area is unknown. Accurate assessment of both sites is hampered by difficult access and restricted visibility.

The Wanda Wetlands site was colonized in the early 90s. The location, which is roughly equidistant (~1km) from two sports grounds, the Port Stephens Estuary and the Salamander waste disposal and recycling facilities, provides easy access to terrestrial and aquatic dietary preferences, with the added opportunity to forage among a constant source of urban waste. Irregular site checks since 2007 estimate the population of the Wanda Wetlands colony at around 50 birds and relatively stable in numbers.

The new rookery is located in the first of two catchment ponds designed to drain the Salamander Sports Complex (**Figure 1**), which is built on saltmarsh reclaimed by infill generated by the neighbouring waste disposal facility. The site is part of a BirdLife Australia atlassing route (Site ID 267484-5; Fixed Route 1-2hrs). Australian White Ibis have been recorded on 92% of the monthly bird surveys conducted since January 2007 (**Figure 2**). Surveys between 2007 and 2009 recorded the presence of one to five ibis foraging in the pond, but from July 2009 numbers have slowly increased, although no evidence of colonization was observed. Surveys in February and March 2010 recorded consecutive high counts of 123 and 56 ibis foraging on the waste heaps, playing fields and ponds within the count area. It's possible that these anomalies may represent birds gathering in response to the end of the Millennium Drought.

Figure 1 – Salamander Sports Complex with two catchment ponds to the east (New colony) and south (2nd Pond)

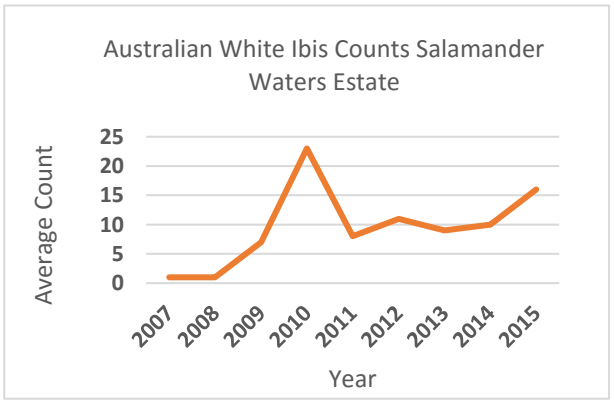

Figure 2 – Annual average counts of Australian White Ibis at Salamander Waters Estate

Colonization activity at the new site was first noted in early July 2015 when approximately 20 birds occupied a group of flooded Melaleucas *Melaleuca quinquenervia* and began noisily constructing nests.

In November 2015, nine juveniles were seen feeding on some small islands adjacent to the rookery. One week later 14 juveniles were observed feeding around the pond, playing fields and waste heaps.

Establishment of the new colony was undeterred by the presence of heavy-duty, earth-moving equipment clearing and landscaping a large area adjacent to the rookery in preparation for a new housing subdivision. It's possible that the increased noise and activity were acceptable to the ibis and other species frequenting the area, because they have adapted to similar, ongoing disturbance by heavy-duty equipment at the nearby waste disposal and recycling sites. During the day there is a constant flow of both light and heavy vehicles along a road bordering the site. Sporting events generate a significant increase in both noise and traffic.

Prior to the ibis colonisation event, Royal Spoonbills *Platalea regia* and Nankeen Night-Herons *Nycticorax caledonicus* roosted in the same location. There are no site breeding records for either species, but lone juvenile night herons and spoonbills have been seen on occasion (**Figure 3**).

Royal Spoonbills continue to co-habit with the ibis, but night-herons are currently scarce. During the December 2015 atlas survey one Nankeen Night-Heron was found at the second pond, located approximately 300m southwest of the new ibis colony.

Figure 3 – Royal Spoonbill foraging with Australian White Ibis at Salamander Waters

Development of the planned housing estate may have a bearing on the colony's future. Objections to noise, odour and scavenging may be raised by new residents, particularly if the colony expands. Currently, both catchment ponds, which are connected by a narrow canal, have aeration systems. Whether these systems have the capacity to cope with the inevitable increase in pond eutrophication is not known.

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Adoption of Laughing Kookaburra chicks

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After a storm in November 2015 two Laughing Kookaburra *Dacelo novaeguineae* chicks were brought into Gloucester, NSW for care. The smaller chick was found on 22 November at Spring Creek, Bucketts Way, about 20km south of Gloucester, and the second larger chick was found on 26 November near Barrington River bridge, north of Barrington village, 7km west of Gloucester, thus one can assume they were not related. Both chicks were given to carer Megan Lewis. They settled in immediately and fed on meat and insectivore mixture. The larger chick was noticeably quieter than the smaller one.

The chicks were placed in an open-fronted cardboard box, the front of which was shut with a wire grid. A few days later, adult kookaburras were heard calling at dawn and a pair observed near the box with prey in their beaks. Subsequently the box was kept open in the daytime and the adults were seen feeding lizards (up to about 25cm long), frogs and insects to the chicks. However, Megan continued to provide extra food in case one was not receiving sufficient.

On 10 January 2016, the larger chick left the box and was seen in trees near the house perched with two adult kookaburras. The following day all three were gone. On 15 January the remaining chick left the box and perched on the nearby Hills Hoist and then higher in a mulberry tree. It refused to come down to be fed and any food left out was eaten by Noisy Miners *Manorina melanocephala*. No calls or sightings of adults were heard and the chick did not return to the box. The following day it had flown.

A group of five kookaburras briefly visited the site on 20 January but it was not possible to say if any were the "adopted chicks" or if the smaller chick had been adopted. Since then kookaburra groups of varying sizes have been heard in the area or perched nearby.

Breeding kookaburras are known to ‘adopt’ unrelated fledglings (Higgins 1999) and this behaviour is often exploited when trying to rehabilitate abandoned or lost fledglings.

Kaplan (2015) in discussing the prevalence of cooperative behaviour in Australian birds mentions that two native bird species, Laughing Kookaburras and White-winged Choughs *Corcorax melanorhamphos*, are known to take in foreign or orphaned juveniles; both species are cooperative breeders.

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Raptors of estuarine Port Stephens

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In 2004, members of the Hunter Bird Observers Club (HBOC) began carrying out boat-based summer surveys of the waterbirds in Port Stephens. Analogous winter surveys started in 2008. The general survey procedure has remained constant (Stuart 2011). The numbers of shorebirds, waterbirds and birds of prey are recorded. Because the surveys are done by boat, most of the latter are estuarine-foraging raptors. Records of woodland birds of prey are a chance event.

The four main raptors recorded in the Port Stephens surveys are White-bellied Sea-Eagle *Haliaeetus leucogaster*, Whistling Kite *Haliastur sphenurus*, Osprey *Pandion haliaetus* and Brahminy Kite *Haliastur indus*. Sea-Eagles and Whistling Kites are the dominant species. Usually, several Ospreys are encountered, and less frequently Brahminy Kites.

The survey method was not designed with raptors in mind. It is unlikely to yield highly accurate numbers for them. They patrol sizable territories and it cannot be excluded that the same bird is sometimes encountered by more than one survey team. However, the survey teams follow set routes each time and therefore should tend to intersect with the same territories in each survey. A relationship would be expected to exist between the counts of raptor numbers during the surveys and the actual numbers of birds present in Port Stephens.

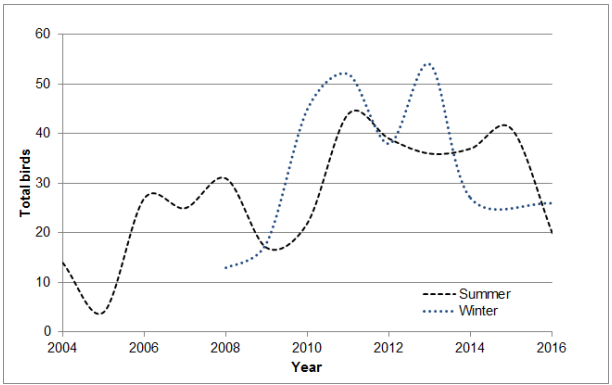

Figure 1. Total counts of estuarine foraging raptors in Port Stephens.

Figure 1 shows the numbers of raptors from summer and winter surveys (there was no winter 2015 survey). The general trend initially was that numbers were increasing. Since 2014, there appears to have been a decline. This has primarily been associated with a decrease in the numbers of Whistling Kites being recorded.

Table 1. Numbers recorded for individual estuarine foraging raptors in Port Stephens.

Year	Season	White-bellied Sea-Eagle	Whistling Kite	Osprey	Brahminy Kite
2004	S	6	6	2	0
2005	S	1	3	0	0
2006	S	15	9	3	0
2007	S	14	9	2	0
2008	S	16	13	2	0
	W	3	4	5	1
2009	S	10	6	1	0
	W	7	10	1	0
2010	S	13	5	4	0
	W	20	18	7	0
2011	S	27	6	10	1
	W	18	16	15	3
2012	S	20	9	10	0
	W	15	15	8	0
2013	S	16	12	8	0
	W	28	16	0	1
2014	S	22	6	7	2
	W	16	5	4	2
2015	S	28	3	9	1
	W	-	-	-	-
2016	S	12	0	7	1
	W	13	6	6	1

Table 1 details the counts for each species. A review of the data has led to the following conclusions about changes that have occurred during the period 2004-2016:

Brahminy Kite: Birds were not resident in Port Stephens initially, but possibly now are. They are known to breed in the north of the Hunter Region and their range has been expanding southwards (Stuart 2016).

Osprey: Recorded in low numbers initially. Since 2010, the population seems to have stabilised and it is now at least 8-10 birds.

White-bellied Sea-Eagle: Numbers fluctuated initially, then increased notably. The relatively low 2016 count is discussed below.

Whistling Kite: The Port Stephens population appeared to increase in 2010-13. However, since then there seems to have been a notable decline.

The count for White-bellied Sea-Eagles was low in the summer 2016 survey and no Whistling Kites were recorded (**Table 1**). In the weeks prior to the survey there had been a prolonged period of heavy rain. Although many mullet were observed to be present in summer 2016, water turbidity levels had deteriorated (T. Kendall pers. obs.). As both species hunt by sight (Marchant & Higgins 1993), possibly they had relocated their hunting efforts to wetland areas or the coastline. It is noted that the numbers of cormorants and pelicans in Port Stephens in the 2016 survey also were relatively low (being 60% of the 13-year average total count for those species). The winter 2016 count for White-bellied Sea-Eagles was closer to normal, lending support for the notion that many birds were foraging away from Port Stephens in February 2016.

ACKNOWLEDGEMENTS

Many members of HBOC have participated in Port Stephens surveys and their willing assistance has always been much appreciated. The surveys have been conducted in collaboration with NSW National Parks and Wildlife Service (Hunter Coast office), with initially Richard Ghamraoui and now Duncan Scott-Lawson making major organisational contributions.

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Black Kite breeding – a first for the Hunter Region

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A raptor nest containing a downy nestling was located by Bruce Watts near the H. H. White bridge over the Goulburn River near Martindale (32^0 25' 57.05"S, 150^0 40' 25.36"E) on 13 October 2015. Two adult Black Kites *Milvus migrans* were observed roosting nearby and flying around the area. No other raptor species were observed in the area. Although it was probable that the nest belonged to the Black Kites, neither bird approached the nest during the period of observation.

A follow-up visit to the site was undertaken by Mick Roderick, Craig Anderson and Joe Stibbard on 27 October 2015. A pair of Black Kites was observed in the area but did not approach the nest. A nestling was observed but positive identification could not be confirmed.

Having obtained details of the location from Mick Roderick, the author decided to visit the site on 29 October 2015. A telescope viewing site was established on the bridge approximately 70 m from the nest which was observed for around five hours. The following observations were recorded.

7.10 am. The head and back of the nestling was barely visible above the top of nest. One adult Black Kite was perched in a tree 100 m west of nest.

8.45 am. Two adult Black Kites flew in from the southeast and soared above the area for a minute or so then flew away. One bird was believed to be a stranger and although no aggression was seen, the second bird was thought to have been keeping an eye on the stranger while it was in the vicinity of the nest. There was no reaction from the nestling or from the other Black Kite perched nearby.

9.00 am. A single adult Black Kite returned. The bird in the nearby tree took off and both soared around the area for 10 minutes. One bird gained height and soared away while the other bird was soaring around the nest area.

9.20 am. The remaining Black Kite landed in a tree 150 m west of the nest.
10.15 am. The perched Black Kite took off and soared around locally just above tree-top height.

10.26 am. Another Black Kite arrived and performed a mock stoop on the bird already present. Both birds soared around the area in close proximity to each other.

10.35 am. One Black Kite was soaring, the other having departed again.

10.40 am. The second Black Kite returned to soar around the area.

10.43 am. One Black Kite landed in a tree away from the nest while the second bird continued soaring.

10.51 am. The nestling watched the Black Kite when it soared near the nest.

11.00 - 11.10 am. Both Black Kites were hunting low over the riverbanks. One landed in a tree away from the nest. The other caught some prey and landed in a tree. One minute later it took off and flew over the nest with the prey. The bird ate the prey while on the wing and dropped what it did not want. The prey was believed to be have been a Blue-tongue Lizard but this could not be verified.

11.20 am. One Black Kite was perched in a tree and the second was absent again.

11.41 am. The second Black Kite returned and landed in the same tree as the other bird. Both birds called softly to each other.

11.45 am. The second Black Kite took off and landed on the nest, staying around 20 seconds. As it took off a second nestling was observed in the nest.

11.50 am. Both nestlings were observed eating while the parents were perched in separate trees nearby. The prey could not be identified.

12.08 pm. Both nestlings had settled down and the adult Black Kites were again soaring around the nest area.

This is believed to be the first confirmed breeding event for Black Kites in the Hunter Region.

The nest was located approximately 10 m above the ground in a River She-oak *Casuarina cunninghamiana*, one of a row of these trees that lined the south side of the river bank. The nest was roughly made from sticks and twigs and measured 60 to 65 cm in diameter. White-faced Herons *Egretta novaehollandiae* were observed nesting in another tree nearby and it is postulated that the Black Kites were using an old White-faced Heron nest in which to rear their young.

A subsequent visit was made by Dan Williams and Stewart Betts to the nest site on 15 November 2015. The nest was observed to be abandoned. An adult Black Kite and a fledgling were observed in the area.

Another interesting observation of the nest site on 29 October 2015 was the presence of Zebra Finches *Taeniopygia guttata* that had taken up residence in the lower part of the nest at the same time as the Black Kites. Two pairs were observed going in and out of the nest and were assumed to have been feeding young.

Roosting waders attacked by Peregrine Falcons

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The Hunter Estuary is host to a diversity of raptors and an abundance of waders, which are potential prey. Raptors, like all predators, are always looking to exploit a break in the alertness of their prey, and to them a flock of roosting waders with bills buried in their back feathers may provide an excellent opportunity for a surprise attack.

The estuary's White-bellied Sea-Eagles *Haliaeetus leucogaster* are perhaps the raptor on which the wader's eyes are most diligently trained, and for good reason, as water birds appear to be a highly favoured prey of local sea-eagles. However, one day during the study, I observed the flying skills of the wader flock tested to their limit by a pair of Peregrine Falcons *Falco peregrinus*.

The following observations were made during a late afternoon high-tide wader survey in the winter of 2004 with the wader flock settled on one of their dyke roosting sites. Their roost appeared to be a very exposed site between the broad expanse of the river to their east and a full dyke pond (number 3) fringed by mangrove trees to their west; however, they appeared to prefer this open circumstance, due to the vigil they can keep on the estuary.

Suddenly the birds became alert and all lifted their heads together, which alerted me to a pair of Peregrine Falcons approaching from up the estuary to the north. Flying in at sufficient height to generate the required speed for an assault the peregrines made directly for the flock; the tercel (male) in the lead with the larger falcon (female) following close behind. The waders responded immediately and took to the air, but not up or out over the river as might be expected, instead they headed for the dyke pond. The waders appeared to have a strategy, they held close ranks and kept very low hugging the water as a refuge, apparently hoping to limit the attack options of the falcons. In response the falcons had their own strategy, the tercel would lead an attack followed closely behind by the falcon some 20 metres back. The tercel would fly at the centre of the flock in what appeared to be a tactic to scatter and disorient the waders and his partner would follow immediately behind in the hope of capturing an isolated bird. The waders were clearly rattled by the attack with Eastern Curlew flying full speed into dense mangroves to escape. The falcons made a number of assaults on the flock until one of their stoops enabled them to successfully separate a Bar-tailed Godwit away from the flock and the falcons were then able to herd it out over the more open water of the river.

The tercel headed for the sky while his partner closely chased the zigzagging godwit, which was still keeping very close to the water. At this point the tercel's reason for gaining elevation came into play. While his partner occupied the godwit by sticking closely to its tail, he used his elevation to generate speed for a lightning run at the godwit, which the godwit evaded. The tercel used the speed of the initial run to swoop up high again for another run and so they continued, the falcons using this teamwork strategy in order to wear down the zigzagging godwit. After a number of stoops the godwit tired and dove headlong into the river with the falcon closely passing over the spot where it disappeared. The godwit surfaced and sat atop the water in a duck-like manner, to which the falcon responded with a low assault. As it drew near, the godwit duck-dived out of harm's way and the Peregrines finally gave up on it.

However, the Peregrines were not finished for the day, they immediately went back to the flock and once again employed the twofold assault on the waders, with the tercel in the lead followed closely behind by his partner. After a couple of stoops they separated another bird out of the flock, this time a Black-tailed Godwit, and out over the river they went again, the falcon close on the godwit's tail, the tercel stooping over and over repeatedly to try to capture the bird or find a crack in the godwit's escape manoeuvres that the closely following falcon could exploit.

This pattern of attack went on for some time, but the diminutive godwit, which seemed completely out-gunned by its muscle-bound adversaries, continued to evade all attempts by the falcons to

capture it until it wore them both out and they gave up, flying away from their intended prey clearly out-manoeuvred and out-lasted.

For the first time since the attack had begun the Black-tailed Godwit left the proximity of the water and flew high heading north, its survival a testament to its capable endurance. Although the flying prowess of Peregrines is renowned, upon reflection that godwits can fly thousands of continuous kilometres during migration, it made me wonder who the underdog really was.

Studies in North America have demonstrated that waders forage in zones on mudflats which are away from the shoreline to minimise predation by Peregrine Falcons (Pomeroy 2006). The foraging zones selected represent a trade-off between food abundance and safety. The behaviour reported in this note suggests that similar trade-offs may apply to diurnal roost site selection. The importance of the ponds in isolating the roost site on the dykes from cover which can be used by raptors and in providing a confined area in which the waders can out-manoeuvre raptors like the Peregrine Falcon in flight may have been underestimated previously.

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Book Review

An Atlas of the Birds of NSW & the ACT, Volume 2 Comb-crested Jacana to Striated Pardalote

by Richard M. Cooper, Ian A. W. McAllen, Christopher C. P. Brandis and Brian R. Curtis (2016)

New South Wales Bird Atlassers Inc, 674 pp, numerous tables, graphs and maps.
Hardback, A4 format, $160, ISBN 9780957704749

The New South Wales Bird Atlassers have published Volume 2 of The Atlas of NSW and ACT birds (Atlas), including those of the western Tasman Sea. The volume contains information on 165 resident and migratory species from Comb-crested Jacana to Striated Pardalote. For each species, there are maps, graphs and tables that summarize the reported distribution, breeding distribution, seasonal and historic range changes, together with monthly breeding records and monthly and annual reporting rates. The text provides a summary of what is known about the occurrence, distribution, breeding biology, movements, history and current status of each species.

A detailed description of the methodology and reporting techniques used to prepare the individual species accounts was included in a review of Volume 1 in *The Whistler*, Volume 8, 2014. The same style and layout has been continued in Volume 2. The Atlas provides quantitative data of trends that will be invaluable in developing environmental policy, minimising future impacts and planning more cost-effective research and conservation programmes. The long-term data set and analysis used to prepare the Atlas provides a baseline against which future changes and the effectiveness of conservation measures can be evaluated.

The Atlas will not be a reference source of first choice for the average bird enthusiast. It will appeal mainly to more technically minded ornithologists, conservation organisations, wildlife managers, environmental consultants, scientists and government agencies. However, I would encourage anyone who can access a copy to read the section on their favourite species. The majority of the information is not available in field guides or the Handbook of Australian, New Zealand and Antarctic Birds (HANZAB) and provides a clear understanding of the status of each species and where conservation efforts should be targeted.

Change in annual reporting rate is the prime quantitative tool used to illustrate the status of species and relies on the assumption that change in reporting rate can be used to infer change in abundance. It also relies on the assumption that survey effort is uniform. In some instances however, a bias in regional survey effort has influenced reporting rate trends and these are highlighted in the text.

At first glance the volume presents a depressing picture for the future of approximately one half of the species described. Around one quarter of the species are classified as threatened under the *NSW Threatened Species Conservation Act 1995* and/or the federal *Environment Protection and Biodiversity Conservation Act 1999*. Most of the threatened species are characterised by significantly reduced distribution and rapidly declining annual reporting rates.

Another quarter of the species described that are not classified as threatened, also exhibit declining reporting rates, particularly since 1990. However, some of the declining reporting rate trends are an artefact of biased survey effort. Species with large populations and widespread distribution are judged not to warrant conservation concern at this time. Further, the decline in reporting rate for some species affected by prolonged drought, particularly those with 'boom-bust' life cycles, may only be a temporary effect. The Atlas provides a sound basis for making decisions to implement closer monitoring of any of these species in the future.

When the majority of resident species are considered as a whole there is an overarching pattern of consistent decline of small woodland species at the expense of larger, more mobile species that have adapted to anthropogenic change. Readers may be surprised to learn that reporting rates for all thornbill species, except Brown Thornbill are declining, as are those of both pardalote species. The trend is the same for Western Gerygone, Weebill, Southern Whiteface, Southern Emu-wren, and all the heathwrens and fieldwrens. The main factors producing this decline are undoubtedly clearing and fragmentation of habitat, drought, over-grazing and climate change.

The Atlas also highlights the success of some species that have increased their distribution and reporting rate. For example, the large cuckoo species (Pheasant Coucal, Eastern Koel, Channel-billed Cuckoo, Pallid Cuckoo) all exhibit increased reporting rates. This contrasts with the smaller cuckoo species (Shining Bronze-Cuckoo, Horsfield's Bronze-Cuckoo, Fan-tailed Cuckoo) all of which have declining trends. This decline sadly parallels that of those small woodland species that act as hosts.

The Swift Parrot, a Critically Endangered species with specialist foraging requirements is widely recorded across eastern NSW but reports are so varied as to not provide a definitive trend. In contrast, the iconic Superb Parrot, another threatened species with specialist foraging requirements, exhibits an increase in reporting rate.

Many migratory waders that are not classified as threatened exhibit a decrease in reporting rate in NSW and are a matter for concern. This includes Common Greenshank, Common Sandpiper, Little Curlew, Grey-tailed Tattler, Ruddy Turnstone and Whimbrel. This section of the Atlas highlights the 'coastal centric' view many of us take towards this group. Common Sandpiper, Marsh Sandpiper, Common Greenshank and Ruddy Turnstone are some of the migratory waders that are widely reported across the rivers and wetlands of inland NSW. While considerable focus is placed upon conserving coastal habitat, the Atlas highlights the need for conserving inland habitat as well.

Unfortunately, the data cut-off of 2006 for trend analysis pre-dates the escalation of threat to many species that has occurred over the past decade, particularly in the Hunter Region. Significant migratory wader habitat loss has also occurred in East Asia over the past decade. More recent data will be required to fully assess the impact of these recent changes.

The NSW Bird Atlassers data set is the longest ongoing set collected with consistent methodology in NSW. The extensive bibliography accompanying the text will be a major asset to future researchers. The authors of the volume and the thousands of bird surveyors who have contributed to its production over several decades are to be congratulated for their efforts.

Volume 3 is planned to be published in 2018 and will cover species from Eastern Spinebill to Common Greenfinch, as well as vagrant species and the birds of the Lord Howe group.

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The *Whistler* – Instructions to Authors

The *Whistler* is an occasional publication of the Hunter Bird Observers Club Inc. (HBOC), which is based in Newcastle. HBOC members are active in observing birds and monitoring bird populations in the Hunter Region. This journal-style publication is a venue for publishing these regionally significant observations and findings. The journal publishes three types of articles:

1. **Contributed Papers**
2. **Short Notes**
3. **Book Reviews**

Authors should consider the appropriateness of their study to this publication. The publication is suitable for studies either geographically limited to the Hunter Region or with obvious relevance to it. Papers attempting to address data and issues of a broader nature should be directed to other journals, such as *Corella*, *Australian Field Ornithology* and *Emu*. Contributed papers should include analyses of the results of detailed ecological or behavioural studies, or syntheses of the results of bird monitoring studies. These may include comprehensive annotated species lists of important bird areas and habitats. Such data would then be available for reference or further analysis in the many important issues of bird conservation facing the Hunter Region.

Communication of short notes on significant bird behaviour is also encouraged as a contribution to extending knowledge of bird habits and habitat requirements generally. Reviews of bird books are also solicited, with the intention of providing a guide for other readers on their usefulness regionally and more broadly.

General Instructions for Submission

Manuscripts should be submitted electronically; please attach your manuscript to an email as a Microsoft Word document. Charts should be submitted as an Excel file. Authors should adhere to the instructions for each type of submission:

Contributed Papers

- Manuscripts should be up to 12 pages in length (longer in exceptional circumstances) and of factual style.
- They should include a summary of approximately 250 words.
- An 'Introduction' or 'Background' section introduces the aims of and rationale for the study and cites any other work considered essential for comparison with the study.
- A section on 'Methods' describes the location of the study, citing map co-ordinates or including a map, and describing how observations were made and data were collected and analysed.
- A section on 'Results' includes description and/or analysis of data highlighting trends in the results; this may be divided into subsections if more than one body of data is presented; use of photos, drawings, graphs and tables to illustrate these is encouraged.
- A section headed 'Discussion' should attempt to set the results in a wider context, indicating their significance locally and/or regionally; comparison with national and international work is optional, as is the discussion of possible alternative conclusions and caveats; suggestions for future extension of the work are encouraged.
- A final section headed 'Conclusion[s]' gives a concise summary of findings, usually without introducing any new data or arguments.
- Appendices of raw data and annotated lists of bird species and habitats can be included in tabular form at the end of the article.
- References should be cited in brief within the text of the article, and full references should be listed at the end of the text after any Acknowledgements and before Appendices and Annotated Lists. References should be formatted as per the formatting instructions below.
- The preferred layout described above can be modified at the Editors' discretion.

Short Notes

- Should be no more than 4 pages of descriptive or prosaic style.
- Should provide an adequate description of the location of observations, a brief rationale for documenting the observations, and a cogent description of observations; similar relevant observations should be cited with references if appropriate.
- References should be cited and listed as for contributed papers.

Book Reviews

- Should be approximately 2 pages of critical assessment and/or appreciation.
- Should introduce the topics and aims of the book as the reviewer understands them, comment on the thoroughness and rigour of content, and conclude with comments on the effectiveness and originality of the book in meeting its aims, particularly for birdwatchers in the Hunter Region area if appropriate.
- References should be cited and listed as for contributed papers.

Formatting Instructions

Although not necessary, it may assist if authors format their manuscripts as follows:

1. A4 size page, portrait layout except for large tables or figures;
2. Margins 2 cm top, bottom, left and right;
3. Title in bold 16pt Arial font, centred;
4. Authors names in 12pt Arial font, centred;
5. Affiliations or addresses of authors, including email addresses, in Arial font, 10 pt size, centred;
6. Section headings capitalized in bold Arial font, 12 pt size, left justified;
7. Sub-section headings not capitalized in bold Arial font, 12 pt size, left justified;
8. First line of each paragraph should not be indented and one line should be left between paragraphs;
9. Typescript should be Times New Roman, 11 pt, except methods, acknowledgements and references which are 10 pt;
10. Figures and Tables to be included at the end of the document in Times New Roman font, 10 pt minimum size, title left justified, below figures and above tables with "**Figure x.**" or "**Table y.**" heading the title;
11. Nomenclature and classification of bird species should follow BirdLife Australia's "Working List of Australian Birds" which can be downloaded from: http://birdlife.org.au/conservation/science/taxonomy. The scientific names of all bird species should be shown in italics after the first mention of their English name in the text. Scientific names should also be included after the first mention of the bird in the summary.
12. References to be cited in the text in parenthesis as close as possible to the information taken from the paper: for one author (Smith 2000), two authors (Smith & Jones 2001b) and more than two authors (Smith *et al*. 2002) with the authors listed in the order they are listed on the original paper;
13. References should be listed in alphabetical order and secondarily by year of publication; if published in the same year then in alphabetical order with an a, b, or c after the year to indicate which paper is being cited in the text (see below); each reference should form a separate paragraph.

Reference Format

Journal articles:
Jones, D.N. and Wieneke, J. (2000a). The suburban bird community of Townsville revisited: changes over 16 years. *Corella* **24**: 53-60.

Edited book Chapters:

Lodge, D.M. (1993). Species invasions and deletions: community effects and responses to climate and habitat change. In 'Biotic interactions and Global change' (Eds. P.M. Karieva, J.G. Kingsolver and R.B. Huey) Pp. 367-387. (Sinauer Associates, Sutherland, MA.)

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Caughley, G. and Sinclair, A.R.E. (1994). 'Wildlife Ecology and Management'. (Blackwell, Cambridge, MA.)

Theses:

Green, R. (1980). 'Ecology of native and exotic birds in the suburban habitat'. Ph.D. Thesis, Monash University, Victoria.

Reports:

Twyford, K.L., Humphrey, P.G., Nunn, R.P. and Willoughby, L. (2000). Investigations into the effects of introduced plants and animals on the nature conservation values of Gabo Island. (Dept. of Conservation & Natural Resources, Orbost Region, Orbost.)

NB:

If these examples are not sufficient, please refer to the references given in this issue or in earlier issues.

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APPENDIX

Summary statistics for species recorded at Belmont Lagoon 2015-16

Common Name	**Scientific Name**	**Max**	**Mean**	**RR(%)**
Little Wattlebird	*Anthochaera chrysoptera*	32	10.6	100.0
Eastern Whipbird	*Psophodes olivaceus*	16	6.4	100.0
Australian Magpie	*Gymnorhina tibicen*	27	13.4	100.0
Black Swan	*Cygnus atratus*	256	59.3	97.3
Crested Pigeon	*Ocyphaps lophotes*	12	4.8	97.3
Australian Raven	*Corvus coronoides*	16	5.2	97.3
Silver Gull	*Chroicocephalus novaehollandiae*	204	28.3	94.6
Red-browed Finch	*Neochmia temporalis*	60	18.4	94.6
Little Pied Cormorant	*Microcarbo melanoleucos*	28	6.3	91.9
Little Black Cormorant	*Phalacrocorax sulcirostris*	83	16.0	91.9
White-cheeked Honeyeater	*Phylidonyris niger*	27	10.7	91.9
Grey Fantail	*Rhipidura fuliginosa*	11	4.4	91.9
Spotted Dove	*Streptopelia chinensis*	7	2.3	89.2
Chestnut Teal*	*Anas castanea*	40	14.6	86.5
Grey Butcherbird	*Cracticus torquatus*	8	3.5	86.5
Magpie-lark	*Grallina cyanoleuca*	9	3.5	86.5
Great Egret	*Ardea alba*	16	4.8	83.8
Welcome Swallow	*Hirundo neoxena*	27	7.8	83.8
Australian Pelican	*Pelecanus conspicillatus*	71	16.0	81.1
Lewin's Honeyeater	*Meliphaga lewinii*	7	3.0	81.1
White-browed Scrubwren	*Sericornis frontalis*	12	3.8	75.7
Rainbow Lorikeet	*Trichoglossus moluccanus*	47	9.7	70.3
Grey Teal*	*Anas gracilis*	32	9.3	67.6
Bar-shouldered Dove	*Geopelia humeralis*	17	4.7	67.6
Brown Thornbill	*Acanthiza pusilla*	11	4.4	67.6
Noisy Miner	*Manorina melanocephala*	10	4.0	67.6
Striped Honeyeater	*Plectorhyncha lanceolata*	15	4.6	67.6
Willie Wagtail	*Rhipidura leucophrys*	8	2.5	67.6
Little Corella	*Cacatua sanguinea*	100	20.3	64.9
Australian Wood Duck*	*Chenonetta jubata*	26	5.9	62.2
White-faced Heron	*Egretta novaehollandiae*	11	2.4	59.5
Superb Fairy-wren	*Malurus cyaneus*	24	7.2	59.5
White-breasted Woodswallow	*Artamus leucorynchus*	31	11.3	59.5
Masked Lapwing	*Vanellus miles*	8	3.0	56.8
Brown Honeyeater	*Lichmera indistincta*	11	3.5	56.8
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	10	2.9	56.8
Silvereye	*Zosterops lateralis*	50	9.1	56.8
Pacific Black Duck	*Anas superciliosa*	7	2.8	54.1
Little Egret	*Egretta garzetta*	15	4.3	51.4
Yellow Thornbill	*Acanthiza nana*	13	3.8	51.4
Pied Currawong	*Strepera graculina*	4	1.7	51.4
Common Myna	*Acridotheres tristis*	37	8.2	48.6
Olive-backed Oriole	*Oriolus sagittatus*	9	2.8	43.2

Common Name	**Scientific Name**	**Max**	**Mean**	**RR(%)**
Galah	*Eolophus roseicapillus*	15	5.8	40.5
Intermediate Egret*	*Ardea intermedia*	13	4.2	37.8
Laughing Kookaburra	*Dacelo novaeguineae*	6	3.0	37.8
Eastern Spinebill	*Acanthorhynchus tenuirostris*	4	2.0	35.1
Great Cormorant	*Phalacrocorax carbo*	4	1.8	32.4
Eastern Rosella	*Platycercus eximius*	6	2.7	32.4
Pheasant Coucal	*Centropus phasianinus*	4	1.4	32.4
Australian White Ibis*	*Threskiornis moluccus*	5	2.2	29.7
Crested Tern	*Thalasseus bergii*	3	1.7	27.0
Eastern Koel	*Eudnamys orientalis*	3	1.7	27.0
Rufous Whistler	*Pachycephala rufiventris*	2	1.4	27.0
Brush Bronzewing	*Phaps elegans*	7	3.3	24.3
Striated Heron*	*Butorides striata*	3	1.3	24.3
Black-winged Stilt*	*Himantopus leucocephalus*	15	6.2	24.3
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	2	1.3	24.3
Dollarbird	*Eurystomus orientalis*	7	2.7	24.3
Australasian Figbird	*Sphecotheres vieilloti*	20	5.3	24.3
Royal Spoonbill*	*Platalea regia*	12	4.0	21.6
Red Wattlebird	*Anthochaera carunculata*	5	2.1	21.6
Yellow-faced Honeyeater	*Caligavis chrysops*	27	9.0	18.9
Grey Shrike-thrush	*Colluricincla harmonica*	4	1.9	18.9
White-bellied Sea Eagle	*Haliaeetus leucogaster*	2	1.3	16.2
Grey Goshawk	*Accipter novaehollandiae*	1	1.0	16.2
Striated Thornbill	*Acanthiza lineata*	8	4.7	16.2
Common Starling	*Sturnis vulgaris*	7	3.7	16.2
Brown Quail	*Synoicusypsilophora*	6	3.0	13.5
Brown Goshawk	*Accipiter fasciatus*	2	1.2	13.5
Yellow-tailed Black-Cockatoo	*Zanda funereus*	3	1.8	13.5
Variegated Fairy-wren	*Malarus lamberti*	8	3.6	13.5
Scarlet Honeyeater	*Myzomela sanguinolenta*	11	3.8	13.5
Eastern Yellow Robin	*Eopsaltria australis*	2	1.8	13.5
Australasian Grebe	*Tachybaptus novaehollandiae*	2	1.5	10.8
White-throated Needletail	*Hirundapus caudacutus*	120	52.8	10.8
Pied Cormorant*	*Phalacrocorax varius*	6	2.8	10.8
Black-shouldered Kite	*Elanus axillaris*	1	1.0	10.8
Caspian Tern	*Hydroprogne caspia*	3	1.5	10.8
Sacred Kingfisher	*Todiramphus sanctus*	2	1.5	10.8
Blue-faced Honeyeater	*Entomyzon cyanotis*	3	2.3	10.8
Golden Whistler	*Pachycephala pectoralis*	4	2.3	10.8
Pied Butcherbird	*Cracticus nigrogularis*	3	1.8	10.8
Fork-tailed Swift	*Apus pacificus*	31	23.7	8.1
Osprey*	*Pandion haliaetus*	1	1.0	8.1
Swamp Harrier*	*Circus approximans*	1	1.0	8.1
Sulphur-crested Cockatoo	*Cacatua galerita*	1	1.0	8.1

Common Name	**Scientific Name**	**Max**	**Mean**	**RR(%)**
Channel billed Cuckoo	*Scythrops novaehollandiae*	5	2.3	8.1
Tawny Grassbird	*Cinclorhamphus timoriensis*	1	1.0	8.1
Straw-necked Ibis*	*Threskiornis spinicollis*	10	5.5	5.4
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	3	2.0	5.4
Shining Bronze-Cuckoo	*Chalcites lucidus*	2	1.5	5.4
White-throated Treecreeper	*Cormobates leucophaea*	1	1.0	5.4
Southern Emu-wren	*Stipiturus malachurus*	2	1.5	5.4
Mangrove Gerygone	*Gerygone levigaster*	1	1.0	5.4
Buff-rumped Thornbill	*Acanthiza chrysorrhoa*	2	1.5	5.4
Noisy Friarbird	*Philemon corniculatus*	22	11.5	5.4
Brown Cuckoo-Dove	*Macropygia phasianella*	1	1.0	2.7
Wonga Pigeon	*Leucosarcia melanoleuca*	1	1.0	2.7
Australasian Darter*	*Anhinga novaehollandiae*	1	1.0	2.7
Black Kite	*Milvus migrans*	1	1.0	2.7
Collared Sparrowhawk	*Accipiter cirrocephalus*	1	1.0	2.7
Nankeen Kestrel	*Falco cenchroides*	1	1.0	2.7
A. Pied Oystercatcher*	*Haemotopus longirostris*	1	1.0	2.7
Red-necked Avocet*	*Recurvirostra novaehollandiae*	1	1.0	2.7
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	2	2.0	2.7
Striated Pardalote	*Pardalotus striatus*	1	1.0	2.7
White-winged Triller	*Lalage tricolor*	1	1.0	2.7
White-browed Woodswallow	*Artamus superciliosus*	10	10.0	2.7
Rufous Fantail	*Rhipidura rufifrons*	1	1.0	2.7
Black-faced Monarch	*Monarcha melanopsis*	1	1.0	2.7
Australian Reed-Warbler	*Acrocephalus australis*	1	1.0	2.7
Tree Martin	*Petrochelidon nigricans*	1	1.0	2.7

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